START

0037074

JUN 22 1994
35 Station 21

ENGINEERING DATA TRANSMITTAL

1. EDT 600222

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Environmental Restoration Field Sampling	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: 200 West Area Carbon Tetrachloride ERA	6. Cog. Engr.: J. D. Fancher	7. Purchase Order No.: N/A
8. Originator Remarks: For release and distribution.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 01 94

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15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-EN-TI-265	N/A	0	Carbon Tetrachloride ERA Soil-Gas Baseline Monitoring	NA	1	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

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1	1	Cog.Eng. J.D. Fancher	J.D. Fancher	6/17/94	N3-05						
1	1	Cog. Mgr. W.S. Thompson	W.S. Thompson	6/17/94	N3-05						
1	1	Proj. Sci. V.J. Rohay	V J Rohay	6/17/94	H6-06						

18.	19.	20.	21. DOE APPROVAL (if required)
J. D. Fancher J.D. Fancher 6/17/94 Signature of EDT Originator Date	G. C. Henckel 6/17/94 Authorized Representative for Receiving Organization Date	W. S. Thompson W.S. Thompson 6/17/94 Cognizant/Project Engineer's Manager Date	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

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	(D)* Rev. No.	• Enter the revision number of the information being transmitted. If no revision number, leave blank.
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*Asterisk denote the required minimum items check by Configuration Documentation prior to release; these are the minimum release requirements.

BD-7400-172-1R (07/91)

Date Received: 6/22/94 DS

INFORMATION RELEASE REQUEST

Reference: WHC-CM-3-4

Complete for all Types of Release

Purpose		ID Number (include revision, volume, etc.)
[] Speech or Presentation	[] Reference	WHC-SD-EN-TI-265, Rev. 0
[] Full Paper (Check only one suffix)	[X] Technical Report	List attachments.
[] Summary	[] Thesis or Dissertation	N/A
[] Abstract	[] Manual	
[] Visual Aid	[] Brochure/Flier	Date Release Required
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Title Carbon Tetrachloride ERA Soil-Gas Baseline Monitoring

Unclassified Category UC- 630

Impact Level N/A

New or novel (patentable) subject matter? [X] No [] Yes
If "Yes", has disclosure been submitted by WHC or other company?
[] No [] Yes Disclosure No(s).

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Author/Requestor (Printed/Signature) Date
J. D. Fancher J.D. Fancher 6/17/94

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SUPPORTING DOCUMENT

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3. Number

WHC-SD-EN-TI-265

4. Rev No.

0

5. Key Words

Carbon Tetrachloride, Soil-Gas, Volatile Organic Compounds

APPROVED FOR PUBLIC RELEASE

6/22/94 D. Dolis

6. Author

Name: J. D. Fancher

J.D. Fancher 6/17/94

Signature

Organization/Charge Code 8B410/PU2BC

7. Abstract

This report contains observations of the patterns and trends associated with data obtained during soil-gas monitoring at the 200 West Area Carbon Tetrachloride Expedited Response Action (ERA). Monitoring performed since late 1991 includes monitoring soil-gas probes and wellheads for volatile organic compounds (VOCs). This report reflects monitoring data collected from December 1991 through December 1993.

Fancher, J. D., 1994, Carbon Tetrachloride Soil-Gas Baseline Monitoring, WHC-SE-EN-TI-265, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

9. Impact Level NA

10. RELEASE STAMP

OFFICIAL RELEASE
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DATE JUN 22 1994
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Carbon Tetrachloride
Soil-Gas Baseline Monitoring

EXECUTIVE SUMMARY

From December 1991 through December 1993, Westinghouse Hanford Company performed routine baseline monitoring of selected wells and soil-gas points twice weekly in the 200 West Area of the Hanford Site. This work supported the Carbon Tetrachloride Expedited Response Action (ERA) and provided a solid baseline of volatile organic compound (VOC) concentrations in wells and in the subsurface at the ERA site. As site remediation continues, comparisons to this baseline can be one means of measuring the success of carbon tetrachloride vapor extraction.

Wellheads and soil-gas points were analyzed using a photoionization detector. Results of the monitoring indicate concentrations of VOCs vary over time and space. Wellhead concentration results spanned a much greater range than shallow soil-gas probe concentrations.

VOC concentrations in wellheads and deep soil-gas probes ranged from less than detectable to exceeding the photoionization detector's capacity of 10,000 ppmv. Shallow soil-gas concentrations ranged from less than detectable to over 100 ppmv.

Concentrations of VOCs were highest at the 216-Z-9 Trench, where levels exceeded 10,000 ppmv at two wells, and at one deep soil-gas probe. Maximum concentrations detected at the 216-Z-1A Tile Field and the 216-Z-18 Crib wells were 1,532 and 442 ppmv, respectively.

Vertical variations in VOCs in wells indicate concentrations are highest in wells with subsurface open areas (perforations or screen) above a locally semi-confining (caliche) layer. In wells with subsurface openings below the caliche layer, VOC concentrations tended to be higher in wells screened just above groundwater.

Distance between a well and the carbon tetrachloride waste disposal area also influences levels of VOCs detected in wellheads. Wells located very near waste disposal sites generally have higher concentrations than wells farther away.

Two seasonal trends have emerged from the data set: VOC concentrations in wellheads and deep soil-gas probes are generally higher in the fall and winter, and VOC detections in shallow soil-gas probes show more detections during winter, spring, and early summer.

Monitoring in wellheads and soil-gas probes around the 216-Z-12 Crib from 1992 to 1994 detected significant quantities of VOCs. The highest wellhead reading was 1,671 ppmv. Previous reports indicated that small quantities of VOCs had been disposed of to the crib. The source and distribution of these VOCs should be investigated further.

An array of multi-level soil-gas points was emplaced in mid-1993 and monitored until the end of 1993. Significant quantities of VOCs were detected in all points at depths ranging from 1.5 m to 33.2 m (5 to 109 ft) below surface. The highest level detected was 1,251 ppmv. This array is located between the 216-Z-1A Tile Field and the 216-Z-12 Crib and infers that a broad plume exists between these two waste disposal sites.

Additional farfield wellhead monitoring farther from the carbon tetrachloride disposal sites in single point and multiple point arrays detected VOCs. As time allows, these anomalies should be investigated to determine the source of the VOCs.

ACKNOWLEDGEMENT

The author would like to thank Bob Schmitt for his efforts in collecting of the field data from the second half of fiscal year 1993 through December 1993. Bob also performed initial data workup and prepared most of the data graphs presented in this report. The work of Enserch Environmental in collating the field data into a workable database is also appreciated.

Carbon Tetrachloride
Soil-Gas Baseline Monitoring

1.0 INTRODUCTION

1.1 PURPOSE

This report contains observations of the patterns and trends associated with data obtained during soil-gas monitoring at the 200 West Area Carbon Tetrachloride Expedited Response Action (ERA). Monitoring performed since late 1991 includes monitoring soil-gas probes and wellheads for volatile organic compounds (VOCs). This report reflects monitoring data collected from December 1991 through December 1993.

1.2 BACKGROUND

Carbon tetrachloride (CCl_4) was used in mixtures with other organics to recover plutonium from aqueous streams at the Plutonium Finishing Plant in the 200 West Area. Both the aqueous and organic phases of the waste stream were discharged to liquid waste disposal sites of various dimensions and construction. The commonality in design is generally a pipe emptying into a gravel layer or emptying directly to the soil column. This allows for rapid infiltration of the waste stream into the soil column.

Organic liquids discharged to the cribs consisted of CCl_4 in mixtures with tributyl phosphate, dibutyl butyl phosphonate, or lard oil. Additional contaminants discharged to the cribs include metals, salts, and radionuclides.

It is estimated that a total of 363,000 to 580,000 L (96,000 to 150,000 gal) of CCl_4 was discharged to the soil column between 1955 and 1973 (DOE/RL 1991) at three separate CCl_4 disposal areas. These disposal areas are the 216-Z-9 Trench, the 216-Z-1A Tile Field, and the 216-Z-18 Crib. The total amount of CCl_4 disposed to the soil represents less than 1/10 of the total liquid (mostly aqueous) disposed to the sites. Discharge of CCl_4 to the soil column was discontinued in 1973.

1.2.1 ERA Background

The 200 West Area Carbon Tetrachloride ERA is being conducted by the U.S. Department of Energy (DOE) at the direction of the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) as a provision included in the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). The ERA was initiated based on concerns that the CCl_4 residing in the soils underlying the 200 West Area is continuing to serve as a source of groundwater contamination (DOE/RL 1992).

Based on the results of initial site investigations and an engineering evaluation and cost assessment, the preferred alternative chosen for removing carbon tetrachloride from the unsaturated zone was soil vapor extraction (DOE/RL 1991). In January 1992, the EPA and Ecology issued an action memorandum directing the initiation of soil vapor extraction. Vapor extraction is accomplished by applying a vacuum to selected wells located within the CCl_4 plume. CCl_4 vapors that are drawn off by the vacuum are adsorbed on granular activated carbon (GAC) contained in canisters. The loaded GAC canisters are transported offsite for regeneration.

2.0 SOIL-GAS BASELINE MONITORING

2.1 PURPOSE

The objectives of soil-gas baseline monitoring were originally defined in the vapor extraction system operation document (Green 1992). These objectives were:

- Measure existing concentrations of CCl_4 in the subsurface before initiating vacuum extraction, to provide a baseline.
- Investigate how the existing concentrations of CCl_4 vary with time.
- Evaluate the impact of vapor extraction on the distribution and concentrations of CCl_4 in the subsurface.
- Provide data to maintain a safe working environment.

As the ERA evolved, baseline monitoring objectives also matured. By fiscal year (FY) 1993, baseline monitoring included an expanded number of data points and farfield monitoring of unsampled wells and additional soil-gas points. FY 1993 objectives outlined in the Wellfield Enhancement Workplan (Rohay and Cameron 1993) were:

- Assist in characterization of the magnitude of the VOC plumes.
- Provide a baseline against which to evaluate the impact of the vapor extraction system on the plumes.
- Identify unknown VOC plumes.
- Provide a baseline to analyze VOC plume migration.

2.2 SCOPE

There are three types of monitoring discussed in this report: routine baseline monitoring, nonroutine farfield monitoring, and sealed well testing. Routine baseline monitoring was the emphasis of field work and is the emphasis of this report.

2.2.1 ROUTINE BASELINE MONITORING

Routine baseline monitoring began with 59 locations in the 200 West Area. In time, additional wells and soil-gas points were added and occasionally removed from the monitoring network. By the end of FY 1993 the baseline monitoring network encompassed 90 locations plus an array of multi-level soil-gas points (Figures 2-1, 2-2, and 2-3). These included 69 wellhead locations, 18 shallow soil-gas probes, 3 deep soil-gas probes, and 33 points at the multi-level soil-gas array (Table 2-1). Discrete samples were collected twice a week. Sampling was normally performed in a specific sequence generally between 9 a.m. and noon.

Table 2-1. Routine Baseline Monitoring Locations

Sample Locations	Number of Locations	Depth
Wellheads	69	Various (23-110 m)
Shallow Soil-Gas Probes	18	1.2 m
Deep Soil-Gas Probes	3	12, 20, and 30 m
Multi-level Soil-gas Points	33	1.5-33.2 m

The 69 wells routinely monitored were installed over a long period of time (1954-1993) using various drilling and completion methods. Thirty-nine of these wells are vadose wells with depths ranging from 23 to 48 m (76 to 150 ft) below surface. Thirty of the wells are groundwater wells, with depth to water ranging from 58 to 65 m (190 to 213 ft) below surface. Most groundwater wells have screens straddling the top of the water surface, although some have deeper open areas (up to 182 m [600 ft] below surface). The various screen lengths are in lithologies including sands, gravels, cobbles, boulders, and clays. Figure 2-4 depicts typical well construction. Additional well construction diagrams can be found in DOE/RL (1991) and Rohay et al. (1992 and 1993). Appendix B presents limited construction data including casing size and type, depth to water, depth to bottom, and additional pertinent data for the wells monitored.

The 18 shallow soil-gas probes were all installed during 1991 and 1992 to a uniform depth of 1.2 m (4 ft). Figure 2-5 depicts a typical shallow soil-gas probe installation.

Figure 2-1. Baseline Monitoring Locations Near the ERA Site

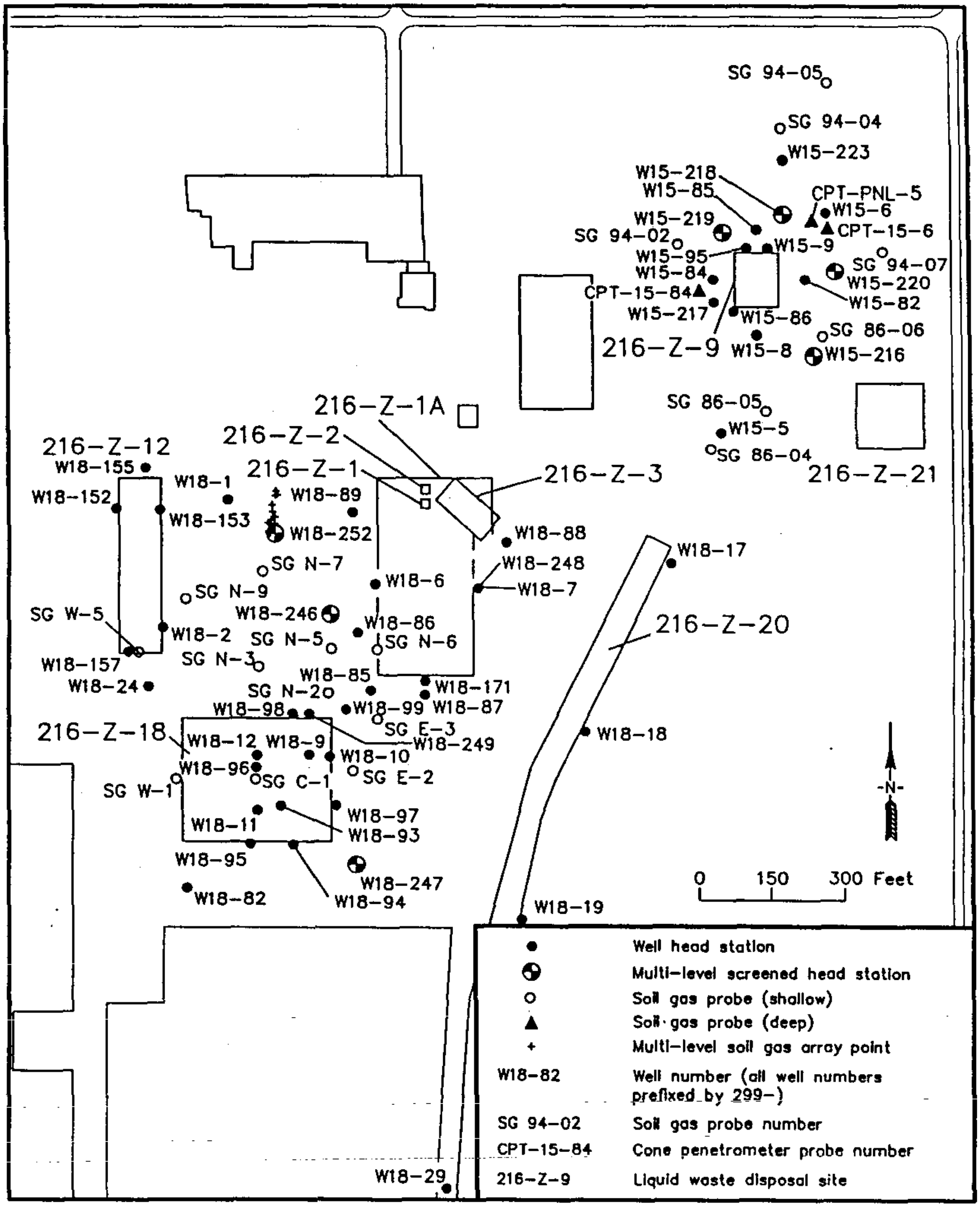

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Figure 2-2. Farfield Baseline Monitoring Locations

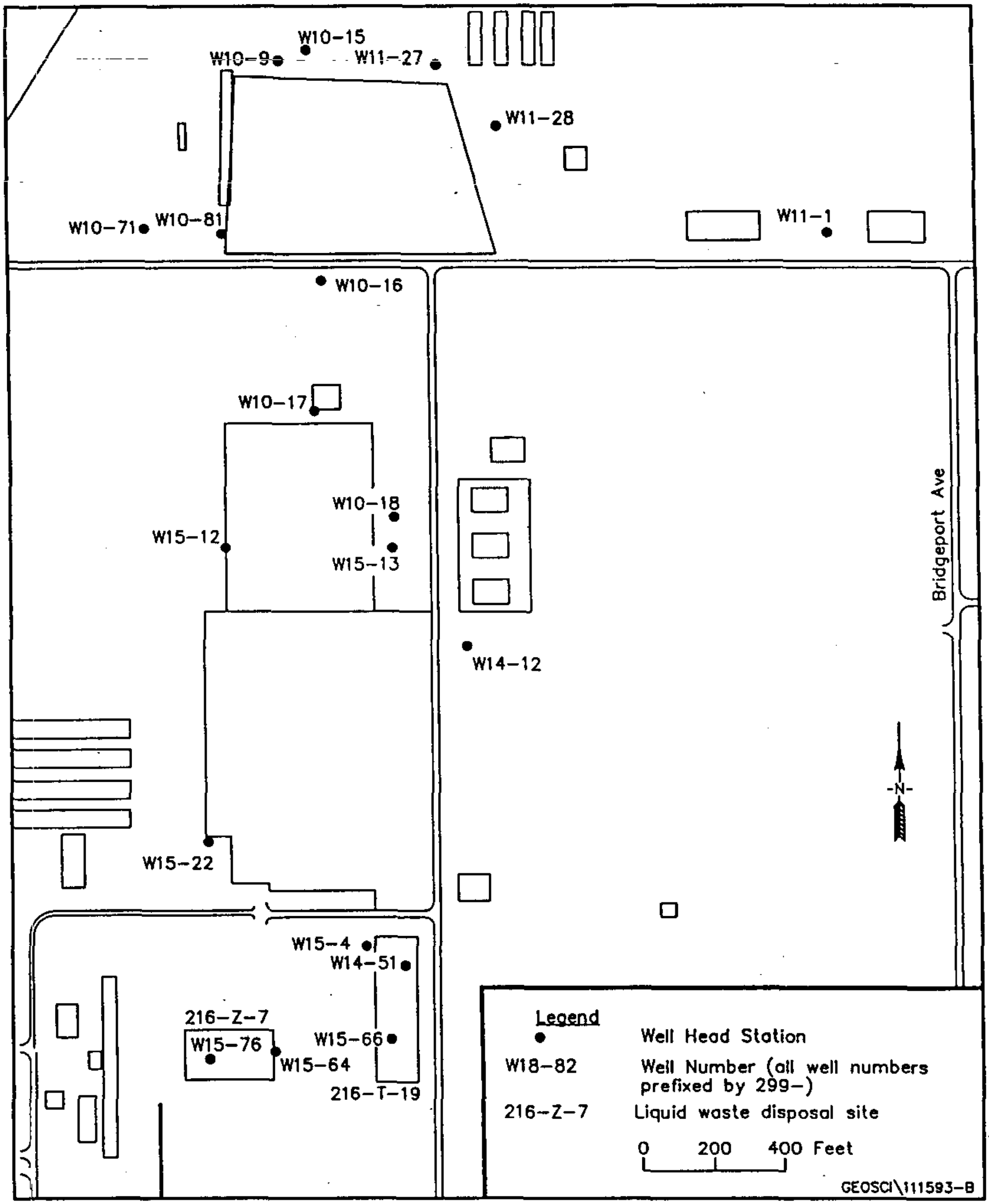


Figure 2-3. Multi-level Soil-Gas Point Locations

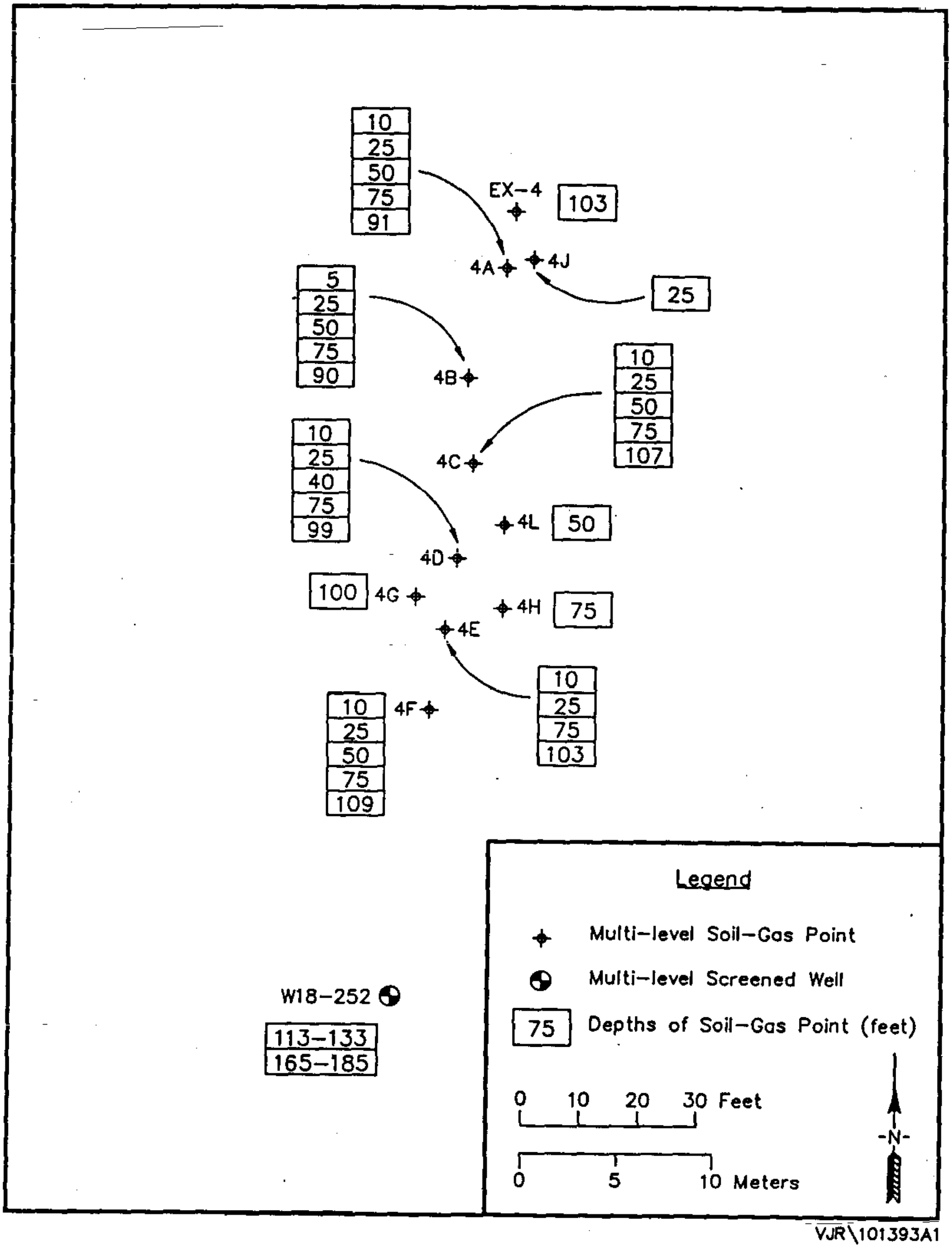


Figure 2-4. Typical Well Construction Diagram

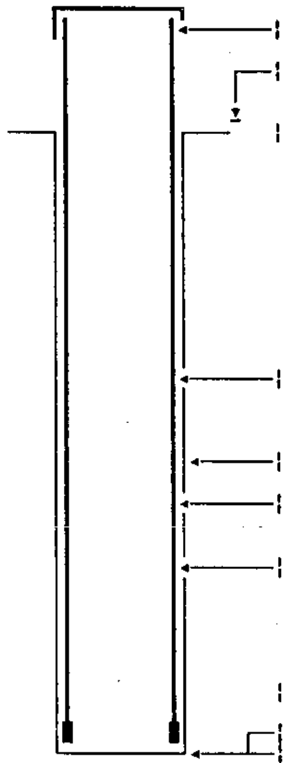
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-W15-95 TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 39,930 E/W W 75,925
Driller's Name: Osburn	WA State Lic Nr: Not documented	State Coordinates: N 445,037 E 2,219,298
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented T___ R___ S___
Date Started: 19Jan59	Date Complete: 21Jan59	Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: SAND & DIRT
5-13: SAND-GRAVEL
13-18: Pea GRAVEL
18-30: SAND-GRAVEL
30-38: SAND-GRAVEL & COBBLE
38-43: SAND
43-80: SAND & SILT
80-91: Sandy SILT
91-100: SAND & SILT

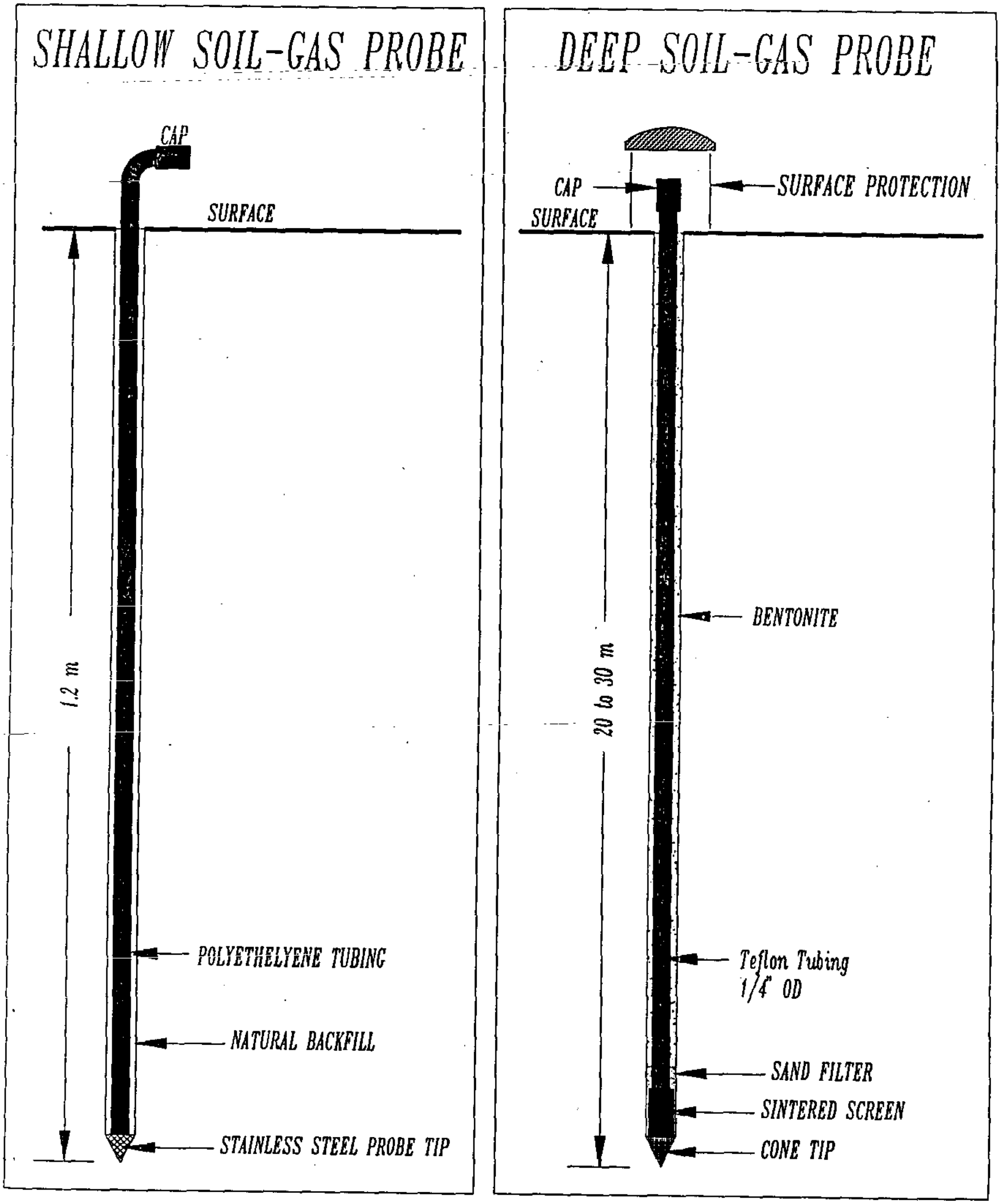


Elevation of reference point: (top of casing) [660.00-ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [100-ft]

Drawing By: RKL/2W15-95.ASB Date: 09Dec92

Reference: HANFORD WELLS

Figure 2-5. Typical Shallow and Deep Soil-Gas Probe Installations



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Three deep soil-gas probes are emplaced near the 216-Z-9 Trench. The 20 m (69 ft) probe (CPT 15-6) was installed in September 1991. Probe CPT 15-84 was emplaced in August 1992 at a depth of 12 m (39 ft). Probe CPT PNL-5 was installed at a depth of 30 m (98 ft) in April 1993.

During mid-1993 a cone penetrometer was used to install soil-gas points west of the 216-Z-1A Tile Field (Richterich 1993) in support of tracer gas testing at the ERA site. Multi-level soil-gas points were emplaced at many of the locations. Thirty-three soil-gas points were emplaced at depths ranging from 1.5 to 33.2 m (5 to 109 ft) below surface. Figure 2-6 shows a typical installation of multi-level soil-gas points.

2.2.2 NONROUTINE FARFIELD MONITORING

Nonroutine farfield monitoring was the one-time measurement of VOCs in other wells in the 200 West Area. During FY 1993, nonroutine VOC monitoring was performed on 111 wells. These wells were both vadose zone and groundwater wells.

2.2.3 SEALED WELL TESTING

Sealed well testing used a simple field method to estimate the amount of air flowing into or out of wells under varying conditions. Sealed well testing was performed four times.

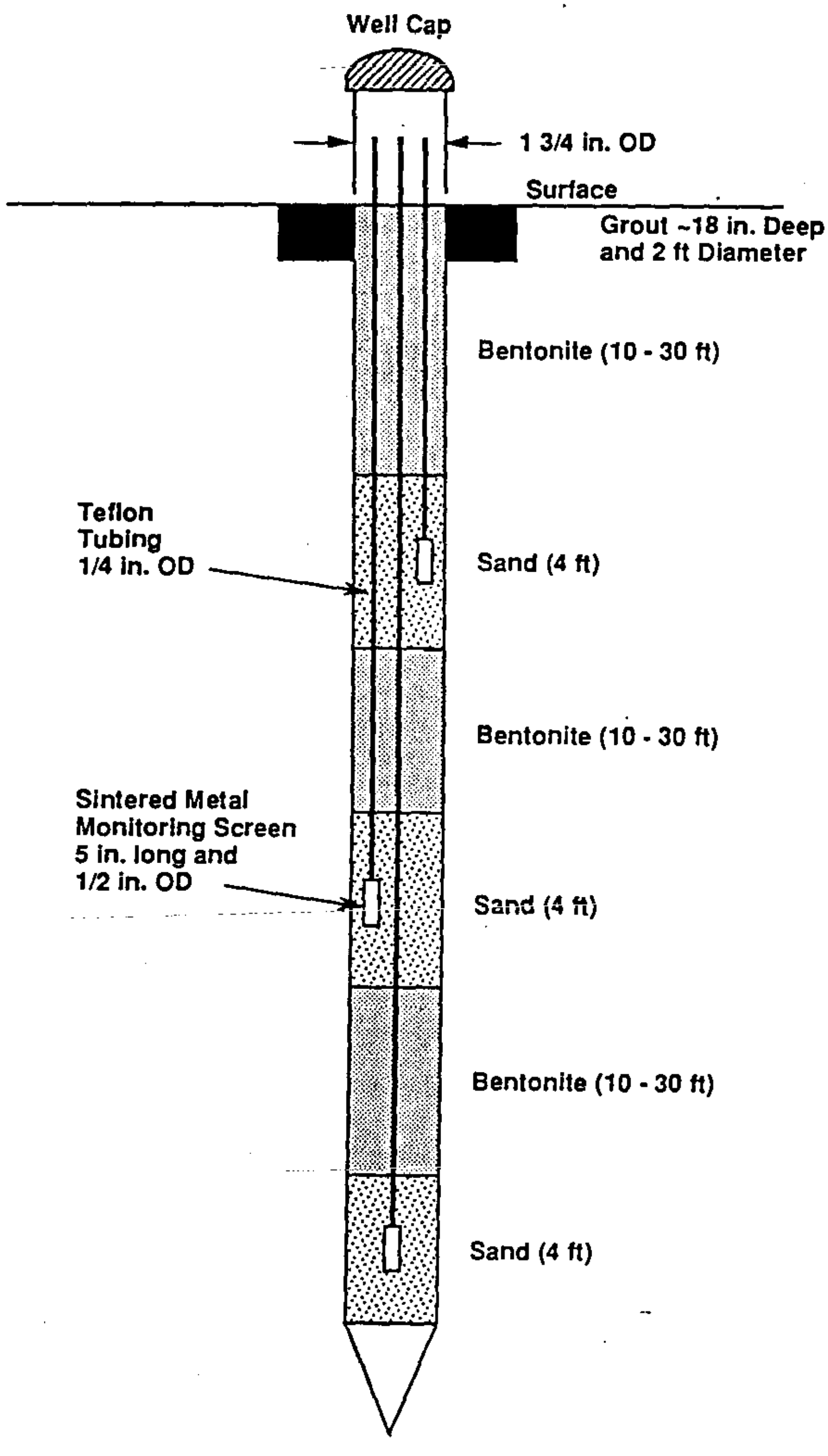
2.3 SAMPLING METHODS

Monitoring is performed at EPA analytical level I (field screening). The sampler approaches the sample location from an upwind direction while monitoring the breathing zone air with a photo-ionization detector (PID). If there are any readings in the breathing zone, the sampler uses a colorimetric tube for CCl_4 to test the breathing zone. If any CCl_4 is confirmed, the sampler exits the work area and contacts the site safety officer.

To begin the wellhead sampling routine, the sampler monitors around the edge of the well cap to obtain a background reading, then lifts the well cap and inserts the PID probe a few centimeters into the well. The sampler allows air to be drawn through the instrument for at least ten seconds to fully equilibrate the system. At multi-level sampling wells (a packer separates two screened intervals), each interval is individually sampled and then resealed.

At soil-gas probes, the sampler takes a background reading a few centimeters from the sample tube and then directly couples the PID to the tube. The sampler extracts at least two purge volumes from the tube before taking the sample. This is done to ensure the sample represents soil-gas, not residual air in the sample tube.

Figure 2-6. Typical Multi-Level Soil-Gas Probe Installation



At both wellheads and soil-gas probes the sampler draws air through the instrument while monitoring the real-time readings. This continues while the readings increase. Once the reading has peaked, the sampler records the maximum value on a data sheet and stores it in the instrument.

2.4 MONITORING INSTRUMENTS

CCl_4 has an ionization energy potential of 11.47 eV and must be monitored with an instrument that has a lamp output greater than 11.47 eV. Monitoring for this project was performed using a Thermo Environmental Instruments Model 580 PID equipped with an 11.8 eV lamp. The range for the instrument is 0.1 to 2,000 ppmv in a benzene-in-air matrix (Thermo Environmental Instruments Inc. 1991). Previous analysis (DOE/RL 1991 and Rohay 1992) with a gas chromatograph indicates that CCl_4 is the primary VOC present in the wellheads and soil-gas probes. The presence of CCl_4 is confirmed at selected sample stations using CCl_4-specific colorimetric tubes manufactured by DRÄGERWERK AG LÜBECK. Based on these results it is assumed that the VOC measured with the PID is CCl_4.

Monitoring instruments are maintained and calibrated daily in accordance with Environmental Investigations Instruction (EII) 3.2 (WHC-CM-7-7). Isobutylene calibration standards are certified and traceable to a national or industry recognized standard.

During FY 1992 and part of FY 1993, the PID response factor was set at 1.0. During mid-FY 1993, at the request of the Westinghouse Hanford Company (WHC) safety organization, the PID response factor was changed to 5.0. This change made the PID more sensitive to VOCs at lower concentrations. Data collected with a response factor of 5.0 have been converted to reflect output as if the original response was 1.0.

If sample readings are not reproducible or sample readings vary for no apparent reason, the instrument is challenged with calibration gas. If the challenge is not within 10% of the original calibration the instrument is recalibrated. At the end of each day's sampling the instrument is challenged with a calibration standard.

2.5 SAMPLING DATA

Data acquired from baseline monitoring are entered on a data sheet and are logged internally within the instrument for later retrieval. Copies of the original field data sheet and instrument printout are maintained in accordance with EII 1.6 (WHC-CM-7-7).

The raw data for the FY 1992 monitoring were presented in a previous publication (Fancher 1993). Raw data for FY 1993 and 1994 monitoring can be found in a series of reports (Rohay 1994 a through g). Data in these reports include sample date, sample location name, sample location number, sample time, background reading, sample reading, reading minus background, the instrument response factor, and individual comments.

Appendix A presents a cumulative maximum, minimum, and average value (including non-detects) for each sample location as well as an average of the detections at each location and the number of samples (including non-detects) and the number of detections (positive points) at each station.

When the term "average" is used in this report it refers to the average of the positive points (detections) of a sample point. The "average" value represents the average concentration that is being vented when air is flowing out of the well. When there are no detections, air is usually flowing into the well; therefore, the average including the non-detects is not used in this report.

Several maps in this report (Figures 4-2, 4-3, and 4-5) contour the maximum VOCs detected in wellheads or soil-gas probes. It was decided to contour the maximum values because they most likely represent equilibrium values. It was believed the maximum value was the equilibrium because the concentrations range from zero to the maximum (equilibrium), depending on barometric pressure fluctuations (and the resultant air inflow [zero detections] or outflow [positive detections]).

3.0 ROUTINE BASELINE MONITORING DATA DISCUSSION

3.1 WELLHEAD SAMPLING DATA

The maximum wellhead detection of VOCs exceeded the field instrument's capacity of 10,000 ppmv at two wellheads: 299-W15-82 and 299-W15-95 (at the 216-Z-9 Trench). Eight additional wells had maximum VOC concentrations exceeding 1,000 ppmv, five of them located at the 216-Z-9 Trench.

The lowest average value of VOCs detected in an ERA site wellhead was 1 ppm at 299-W18-88, and the highest average value was 651 ppm at 299-W15-82. Results of wellhead sampling indicate that concentrations of VOCs vary widely over time and space (Fancher 1992). During the course of sampling, readings ranged from non-detections to several hundred parts per million, and occasionally detections were over 10,000 ppmv.

Appendix B presents limited construction data including casing size and type, depth to water, and depth to bottom. Appendix B also contains the calculated total subsurface open area for the wells monitored. For purposes of this report, open area is defined as the total square inches of well casing open to the subsurface soil (vadose zone).

It is known that wellhead VOC detections (and airflow into and out of wells) are affected by barometric pressure. During periods of low pressure, VOC concentrations are higher. Rohay and Cameron (1992a and 1992b) have previously discussed these effects. Additional work is ongoing. Further discussions are beyond the scope of this report.

3.2 SHALLOW SOIL-GAS PROBE DATA

Levels detected in shallow soil-gas probes are generally lower than levels detected in deep soil-gas probes or wellheads. The highest shallow probe value detected was 132 ppmv at SG 94-02 (northwest of 216-Z-9), while the highest wellhead value detected was over 10,000 ppmv. The distances between a given CCl_4 disposal site and probe locations range from 0 to 58 m (190 ft). Of the 18 stations routinely monitored, the lowest average of the detected values was 3.9 ppmv, and the highest average of the detected values was 27.9 ppmv.

3.3 DEEP SOIL-GAS PROBE DATA

Three deep soil-gas probes are emplaced at the 216-Z-9 Trench. The 20 m (65 ft) deep probe (CPT 15-6) regularly yields high VOC measurements. Results from this probe range from 0 ppmv to over 10,000 ppmv. The average value of VOC levels detected was 1,613.1 ppmv.

The shallower probe, CPT 15-84, was emplaced in August 1992 at 12 m (39 ft). The data set has lower values (0 to 259 ppmv), but often has elevated values on days CPT 15-6 also has elevated readings. The average value of the detections was 28.6 ppmv.

The deepest of the three deep probes, CPT PNL-5, at 30 m (98 ft) deep, was monitored during emplacement and provided detection of CCl_4 ranging in the hundreds of ppmv. After emplacement sampling, the outer steel rods were removed, and the sampling tube was grouted in place. Sampling attempted after emplacement rod removal has not proven successful. Samples were collected on 58 occasions, but VOCs were detected on only 9 occasions. VOC levels detected ranged from 0 to 12.4 ppmv, with an average value of 4.7 ppmv.

3.4 MULTI-LEVEL SOIL-GAS POINTS

Seventy meters (230 ft) west of the 216-Z-1A Tile Field an array of 33 multi-level soil-gas points was emplaced to support tracer gas testing. Many of these points were monitored during the last half of 1993. The highest VOC level detected at the multi-level soil-gas array was 1,251 ppmv at point CPT-4C at 22.8 m (75 ft) deep. The lowest average value of detections at the array was 7 ppmv at CPT-4J at 7.6 m (25 ft), and the highest average of detections was 94 ppmv at CPT-4C at 22.8 m (75 ft).

3.5 216-Z-12 CRIB

Crib 216-Z-12 is located northwest of Crib 216-Z-18 and west of the 216-Z-1A Tile Field. Initially only a few wells were monitored on the south and east of the crib. Concentrations of VOCs in wells and soil-gas probes were higher than expected considering the small quantity of VOCs believed to have been sent to the crib (DOE/RL 1991). In FY 1993 additional wells were monitored around the crib.

The 216-Z-12 Crib received laboratory wastes containing primarily nitrates and a small quantity of CCl_4. The crib is radiologically controlled as an underground radioactive materials area. The highest wellhead reading was 1,671.5 ppmv at 299-W18-153 (east of 216-Z-12), higher than other wellheads at 216-Z-1A or 216-Z-18.

The highest soil-gas probe reading was 97 ppmv at station SG N-9 (east of 216-Z-12), higher than detections at 216-Z-1A or 216-Z-18.

Possible explanations for these high detections include preferred movement of VOCs from the 216-Z-1A Tile Field because of underlying geologic features, or VOCs sent to the 216-Z-12 Crib but not recorded.

3.6 FARFIELD MONITORING

During FY 1993, additional wells north and south of the ERA were added to the routine biweekly monitoring. All but one of these wells with detectable VOCs were screened below the caliche horizon in the groundwater. The origin of these VOC detections is likely VOCs in the groundwater. The ultimate source of these contaminants is beyond the scope of this report. Wells were located near:

- T Tank Farm
- TX Tank Farm
- TY Tank Farm
- 216-Z-7 Crib
- 216-Z-12 Crib
- 216-T-19 Crib
- 216-Z-20 Crib

VOC detections indicate the possibility of additional areas of deep unsaturated zone contamination. These areas are known to be contaminated with CCl_4 in the groundwater. Table 3-1 lists farfield monitoring wells where detected VOC concentrations were greater than 1 ppmv. The highest farfield detection was 49.8 ppmv, recorded at well 299-W15-4, located west of the 216-T-19 Crib. This crib is known to have had CCl_4 discharged to it (Rohay et al. 1993b). Figure 3-1 shows farfield wells monitored and indicates whether VOCs were detected, and the maximum concentrations detected.

Figure 3-1. Maximum VOC Concentrations Detected at Routine Farfield Monitoring Wells

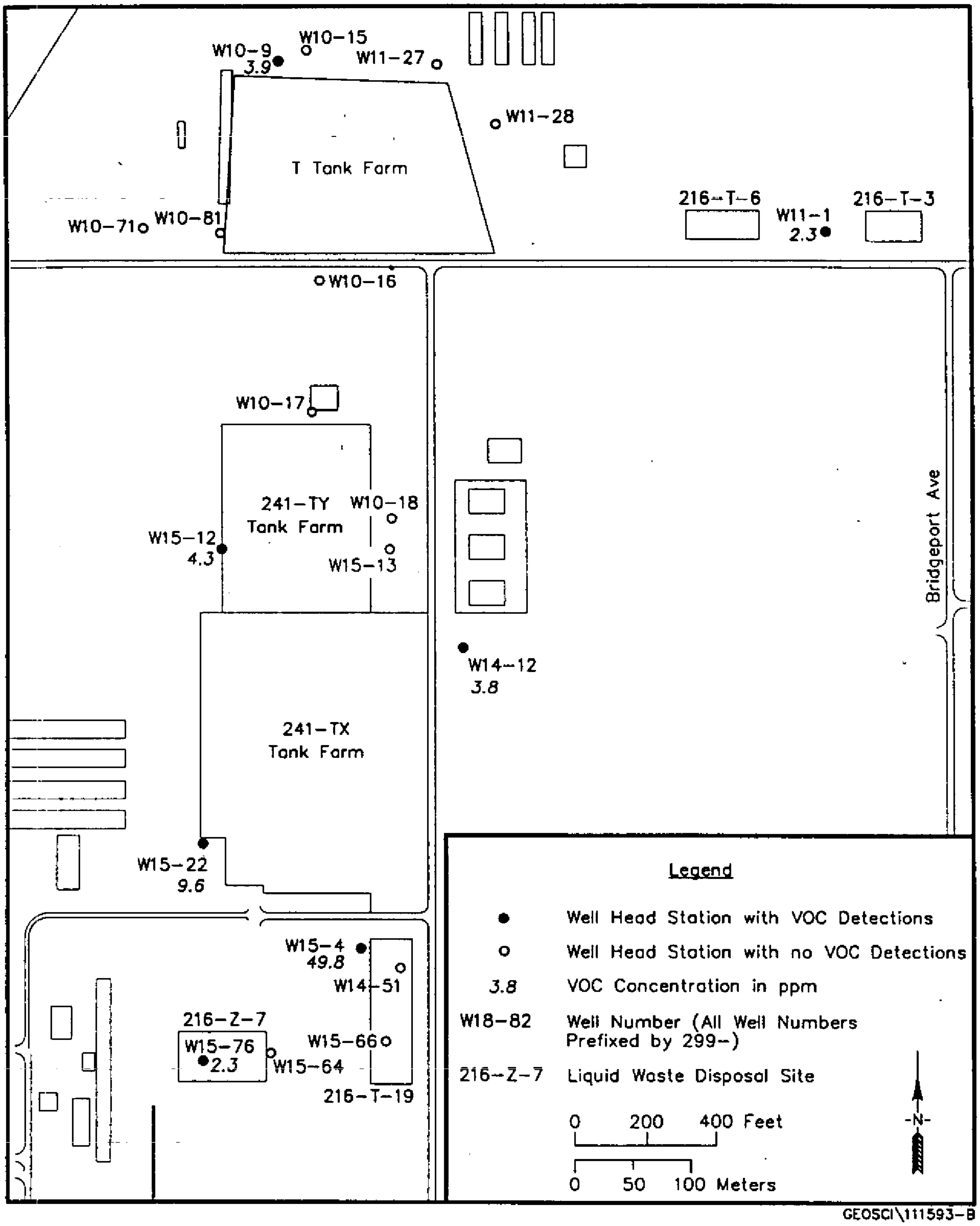


Table 3-1. Routine Farfield VOC Detections

Well Number	Max ppmv	Number of Detects	Number of Samples	Depth (ft) Top of Open Interval	Area
299-W10-9	3.9	3	84	202	North of T Tank Farms
299-W11-1	2.3	3	84	220	West of T Plant
299-W14-12	3.8	2	84	198	East of TX Tank Farm
299-W15-4	49.8	3	80	170	West of T-19 Crib
299-W15-12	4.3	3	84	195	West of TY Tank Farm
299-W15-22	9.6	4	85	198	Southwest of TX Tank Farm
299-W15-76	2.3	3	83	103	216-Z-7 Crib; only well open above caliche

9113290.1093

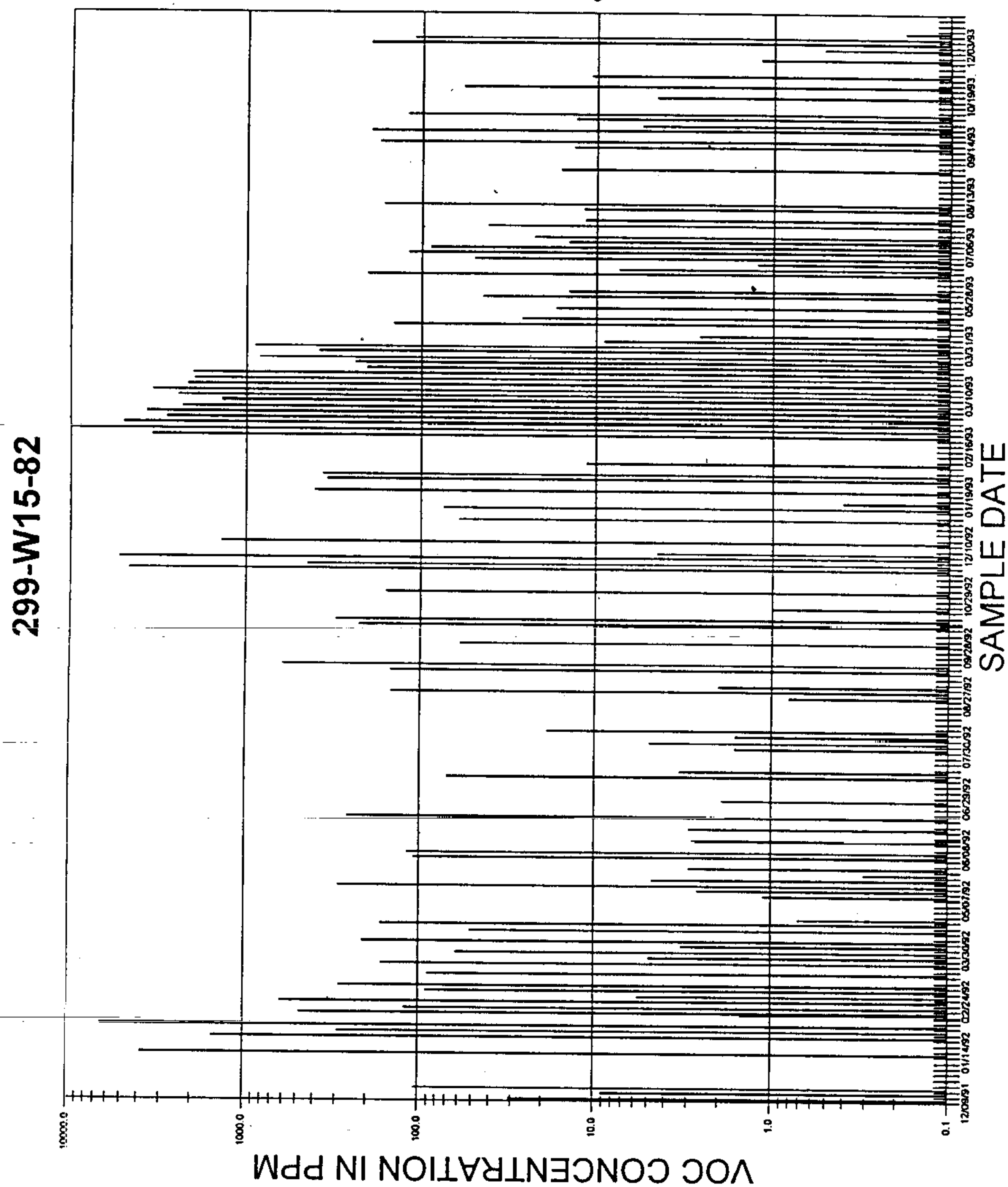
4.0 COMPARISON OF SAMPLING DATA SETS

4.1 PATTERNS OF WELLHEAD CONCENTRATIONS

Wellhead concentrations are highest at the 216-Z-9 Trench by nearly an order of magnitude above concentrations at other areas of the ERA. Commonly venting wells have average detection values in the 26 to 651 ppmv range. The highest wellhead readings exceeded the PID capacity of 10,000 ppmv at 299-W15-95 and 299-W15-82. Figure 4-1 is a plot of maximum VOC concentrations over the entire 25 months of baseline monitoring at Well 299-W15-82. A seasonal trend of generally higher VOC detections in the fall and winter months is evident.

Concentrations of VOCs were highest at the 216-Z-9 Trench, where levels exceeded 10,000 ppmv at two wells, and at one deep soil-gas probe. Records provide a wide ranging estimate (83,000 to 300,000 L [95,895 to 153,220 gal]) of carbon tetrachloride disposed to the 216-Z-9 Trench. If the smaller quantity is correct, the 216-Z-9 Trench received the least amount of carbon tetrachloride of any waste area in the ERA. If the larger quantity is correct, the 216-Z-9 Trench received the most carbon tetrachloride of any waste area in the ERA. Another possible factor contributing to VOC concentrations is the trench size; it is the smallest of any waste area in the ERA.

Figure 4-1. Maximum VOC Concentrations over Time at Well 299-W15-82



Concentrations of VOCs are highest in wells with subsurface openings (perforations or screen) above a local semi-confining geologic feature. The Plio-Pleistocene Unit (34 to 44 m [111 to 144 ft] below surface) contains a horizon of caliche stringers, concretions, and carbonate rich alluvial silts, sands, and gravels (Singleton and Lindsey 1994). The semi-confining caliche layer has a very low hydraulic conductivity. Figures 4-2 and 4-3 present contours of the maximum VOC concentrations measured in wells above and below the caliche horizon. Figure 4-4 graphically presents maximum VOC concentrations of wells routinely monitored.

Distance between a well and the waste disposal area also influences levels of VOCs detected in wellheads. Higher levels are generally detected in wells located very near waste sites than in wells farther away. In wells with subsurface openings below the caliche layer, higher levels of VOCs were detected in the wells perforated or screened just above the groundwater than in those with openings significantly above the groundwater.

Examination of wellhead measurements collected above and below the caliche horizon provides additional insight into the distribution of VOC levels detected at wellheads. Figure 4-5 compares the maximum VOC concentrations over time above and below the caliche horizon at well 299-W15-216. In the area of the 216-Z-9 Trench, the highest above-the-caliche measurements (10,000 ppmv) were collected to the north and east. Lesser though still significant levels were detected to the west. To the south, VOC levels diminished. Below the caliche the maximum detections are found to the northeast.

In the areas of the 216-Z-1A Tile Field and the 216-Z-12 Crib, the maximum levels detected above the caliche fall within the 1,000 ppmv contour in an east-west band stretching from the 216-Z-1A Tile Field to the 216-Z-12 Crib. The VOC levels below the caliche in this area follow a similar pattern but indicate a much smaller area of maximum concentrations. VOCs at the 216-Z-18 Crib occur at significantly lower concentrations and occur in the eastern half of the crib (the western most trench in the 216-Z-18 Crib was never used).

No correlation appears to exist between a well's open area (square inches of subsurface area open to the vadose zone) and maximum parts per million. Some wells with large open areas have high average VOC detections, and others have low average detections. This seems reasonable, considering that some deep soil-gas probes (with an extremely small open area) have VOC concentrations higher than some wellhead concentrations.

Appendix B provides data on individual wells, including casing diameter, well depth, perforation and well screen intervals, and total area of the subsurface (perforation or screen) open to the subsurface. Appendix C explains the method used to calculate the well open areas.

Figure 4-2. Contours of Maximum VOC Concentrations in Wells Screened Above Caliche

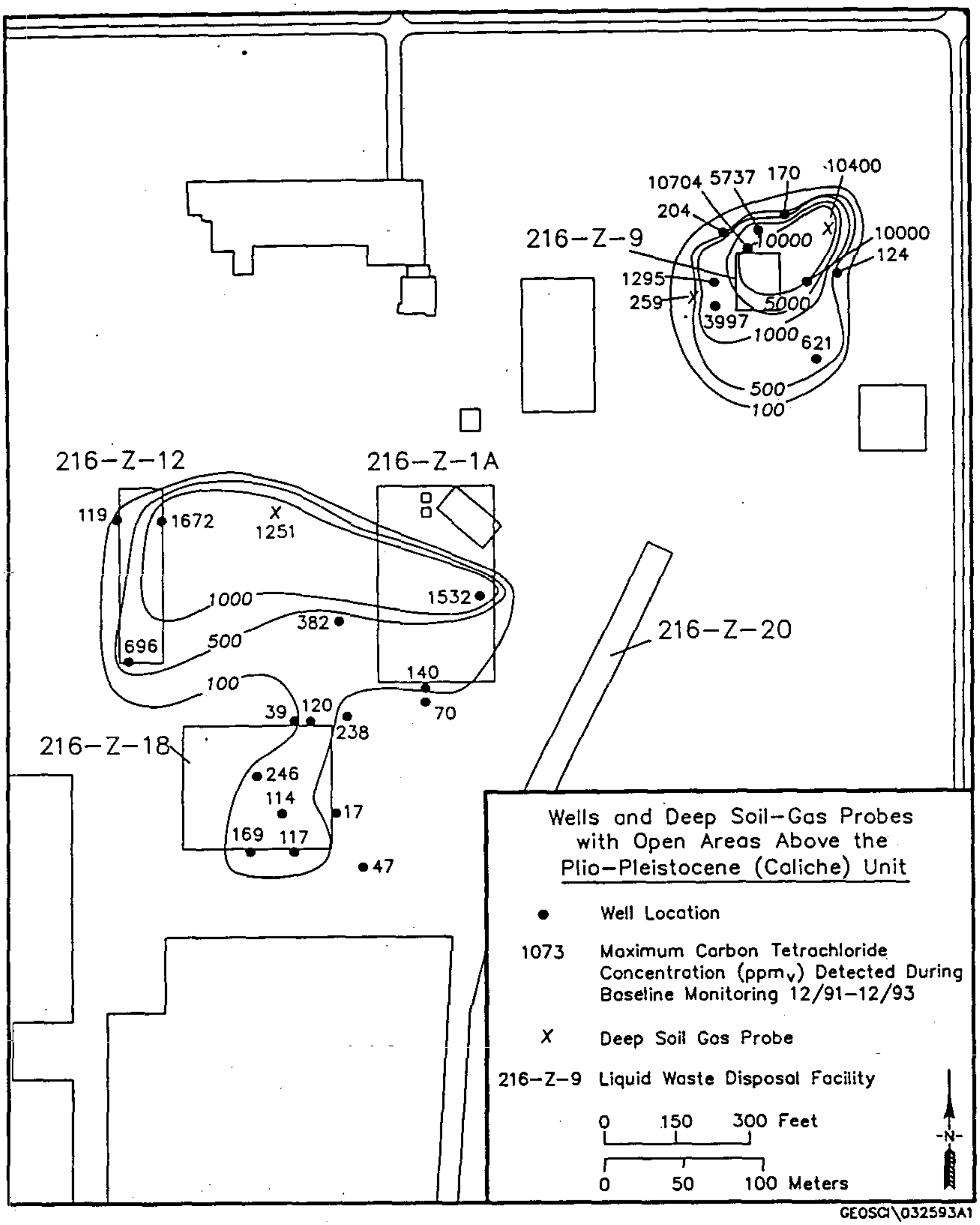
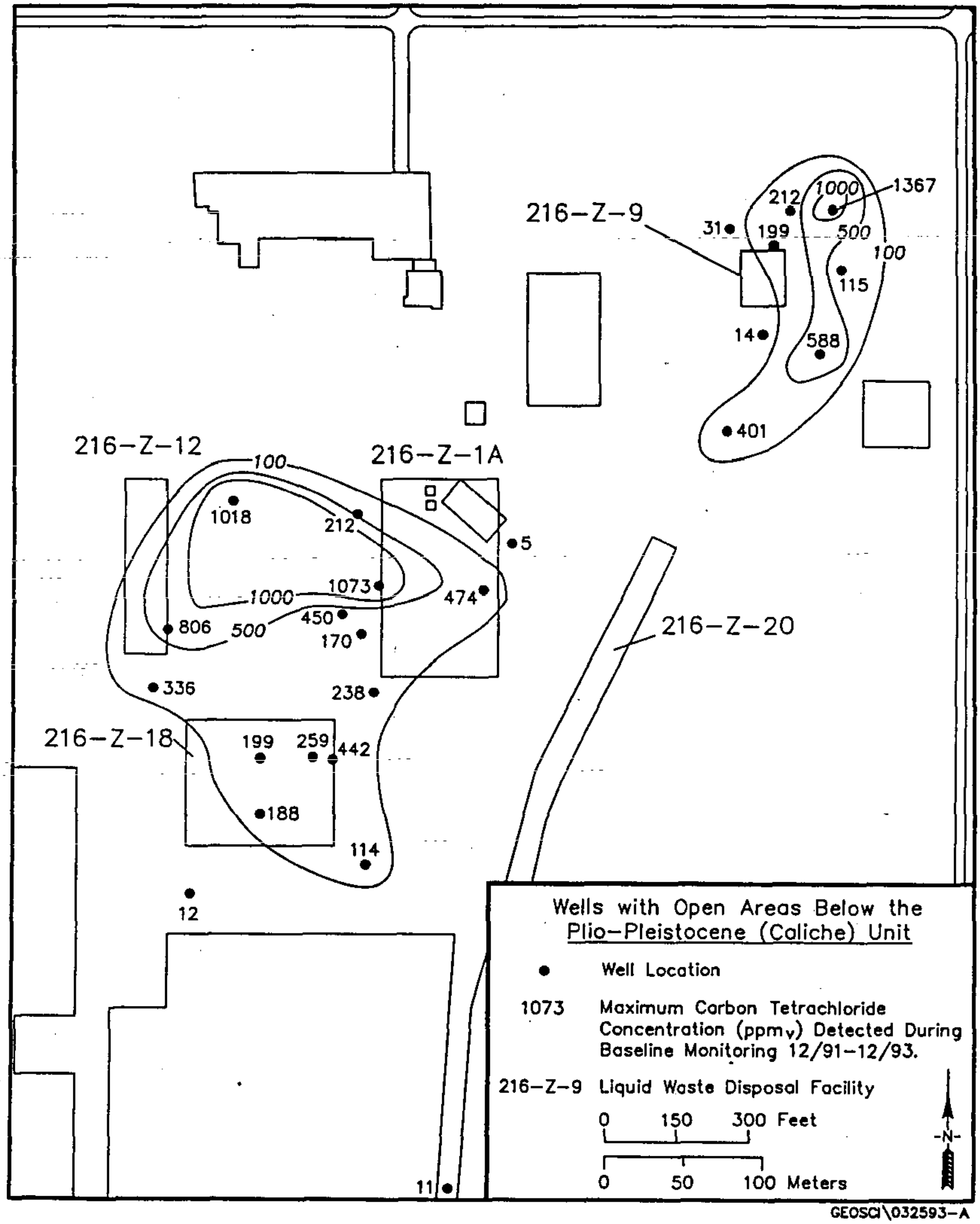


Figure 4-3. Contours of Maximum VOC Concentrations in Wells Screened Below Caliche



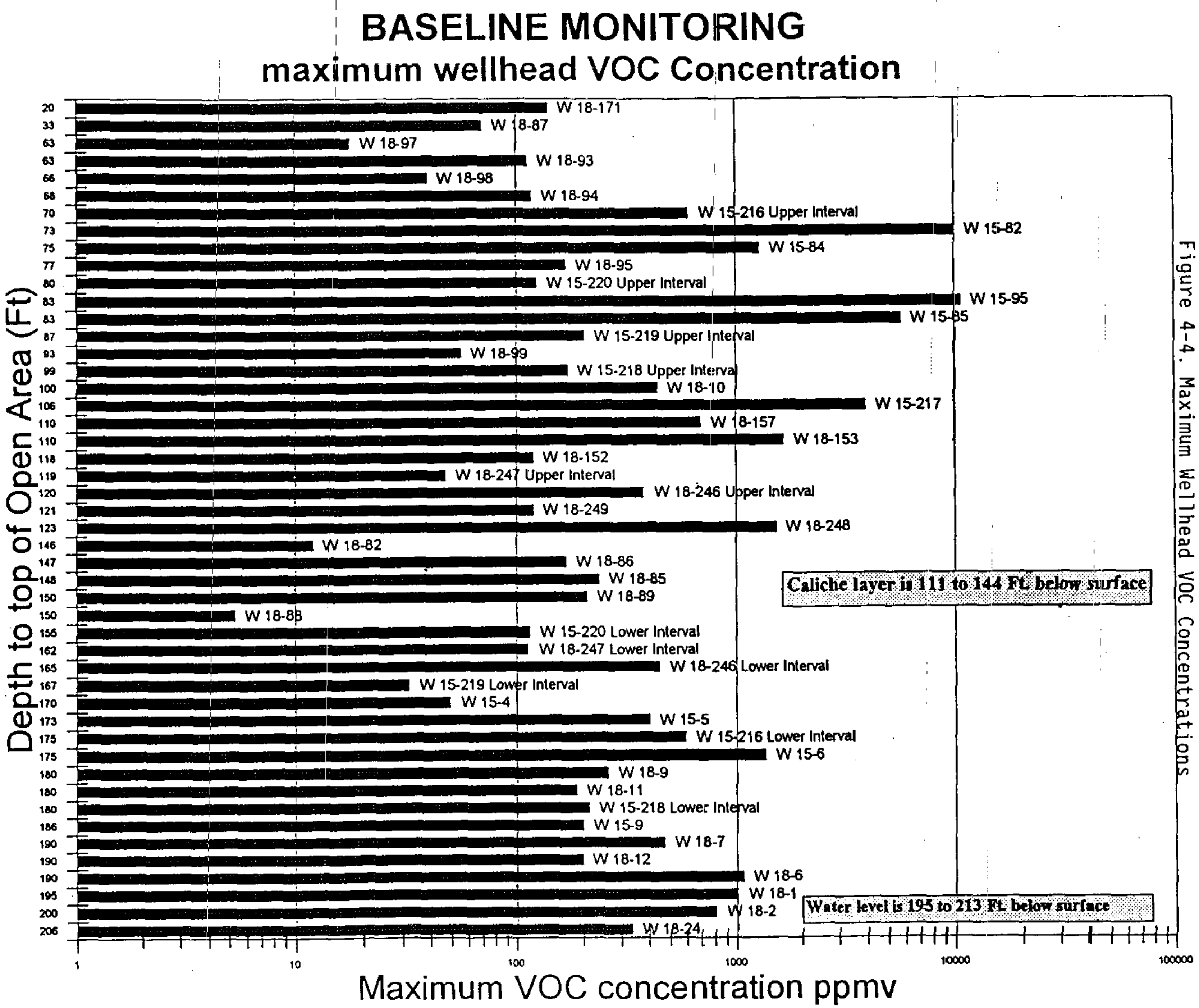


Figure 4-4. Maximum Wellhead VOC Concentrations

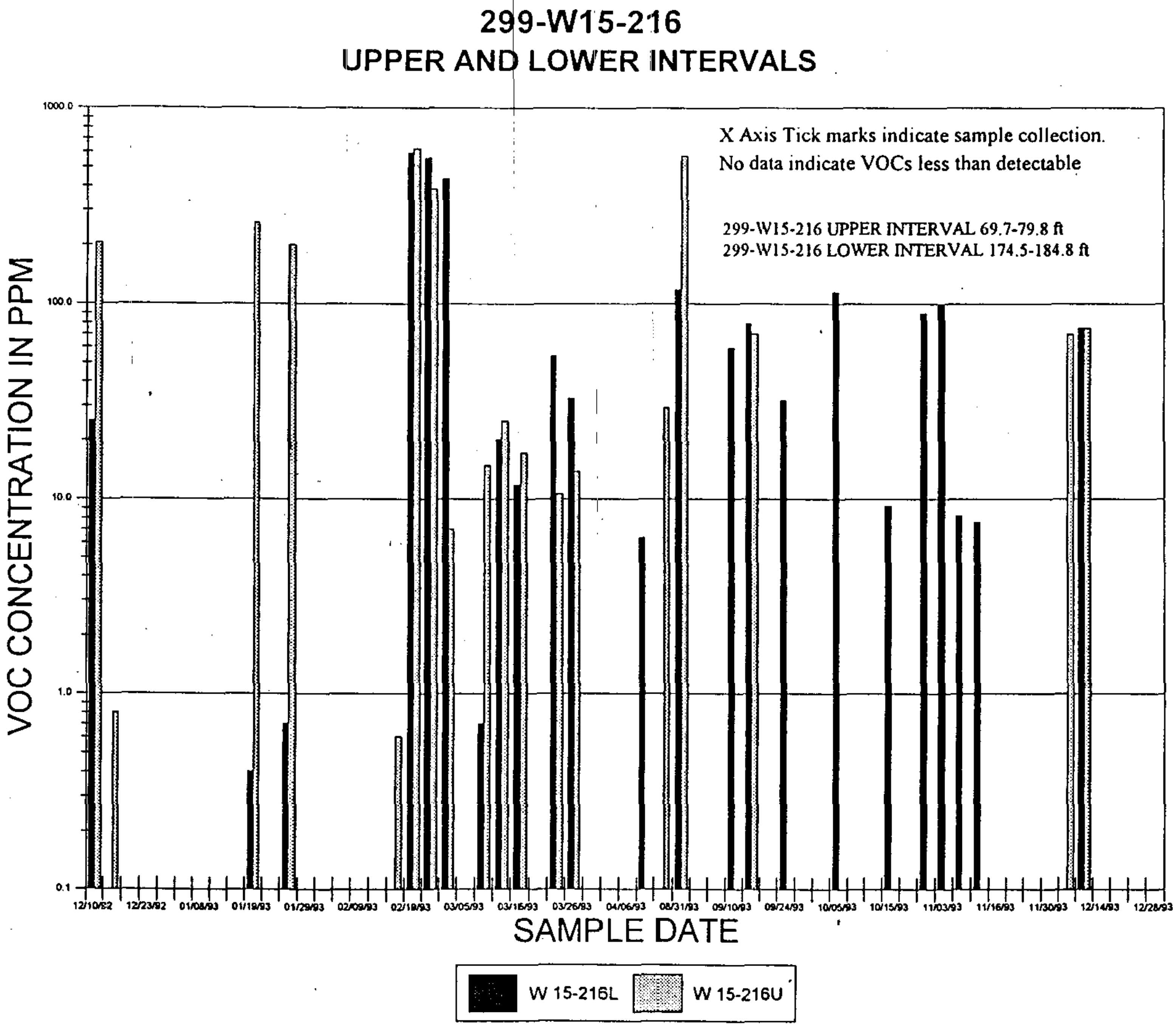


Figure 4-5. Maximum VOC Concentrations Above and Below Caliche at Well 299-W15-216

Levels of VOCs detected in wellheads are affected by barometric pressure. Rohay and Cameron (1992a and 1992b) discuss this relationship. During periods of low barometric pressure, VOC concentrations are higher. This fact has been confirmed on many occasions during field work conducted for this report. Additional related investigative work is underway but is beyond the scope of this report.

4.2 PATTERNS OF SHALLOW SOIL-GAS CONCENTRATIONS

Shallow soil-gas probe VOC concentrations are highest at the 216-Z-9 Trench. At the 216-Z-9 Trench the highest concentration, 132 ppmv, was detected 50 m (164 ft) to the northwest, but relatively high levels were also detected to the south and northeast. In the 216-Z-1A area, the highest shallow soil-gas concentration was 97.4 ppmv, detected 5 m (16 ft) east of the 216-Z-12 Crib. The maximum VOC concentrations detected in shallow soil-gas probes are contoured in Figure 4-6. VOC concentrations at soil-gas probe SG N-9 (located east of the 216-Z-12 Crib) are depicted in Figure 4-7.

Figure 4-8 depicts the shallow soil-gas probe detections and non-detections for each sampling day over the 25-month period. Detections appeared fairly consistently during the first year of monitoring. An apparent seasonality is shown by a high percentage of detections between February and July 1992, and many non-detects during September and October. The pattern appears to continue in 1993, but in a muted form; the muting is believed to be caused by the addition of soil-gas points to the routine monitoring network in January 1993. Detections at these added probes (at the 216-Z-9 Trench) occurred more frequently than at probes in other areas.

4.3 PATTERNS OF DEEP SOIL-GAS CONCENTRATIONS

All three deep soil-gas probes are located at the 216-Z-9 Trench. Due to the limited number of data points, the patterns observed were increasing VOC detections during periods of falling or low barometric pressure, and a seasonal trend of generally higher VOC detections in the fall and winter months. Figure 4-9 depicts probe CPT-15-6 maximum concentrations over the entire 25 months of baseline monitoring.

4.4 PATTERNS OF MULTI-LEVEL SOIL-GAS POINT CONCENTRATIONS

Concentrations of VOCs detected at the multi-level soil-gas array vary widely over time. Previously, Rohay and Cameron (1992a) discussed changing soil-gas concentrations. Figure 4-10 depicts the concentrations detected from five different intervals at location CPT 4F. At most sampling events VOCs were detected in at least one interval in the array location. The highest number of maximum detections were recorded from the 23 m (75 ft) deep point. The 23 m (75 ft) deep point also has the most number of maximum detections. Patterns emerging include a close relationship between the 23 and 32 m (75 and 109 ft) deep points.

The highest detection from this location was recorded at the 8 m (25 ft) deep probe. Every depth location at CPT 4F at one time or another recorded a day's maximum VOC detection.

Figure 4-6. Contours of Maximum VOC Concentrations in Shallow Soil-Gas Probes

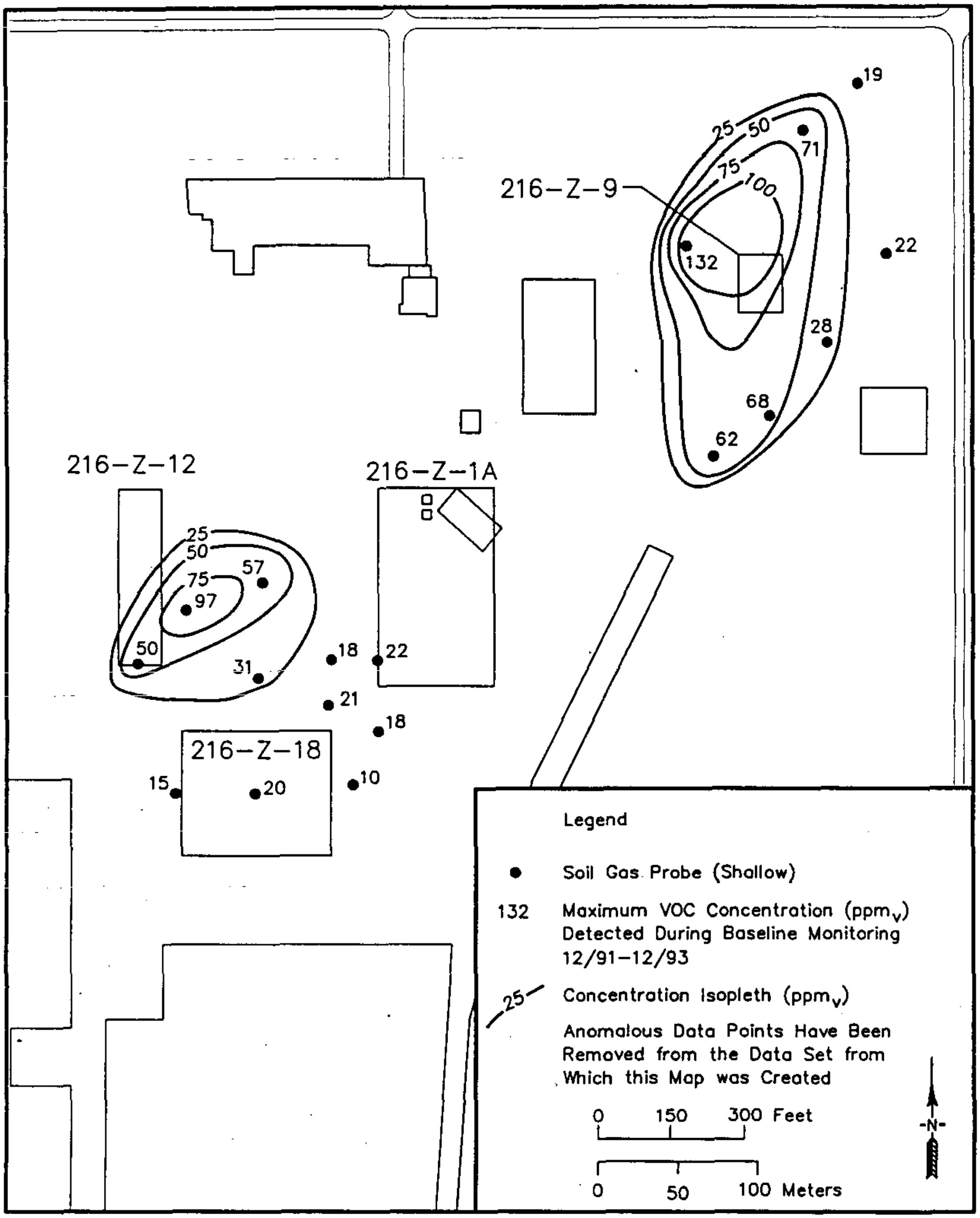


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Figure 4-7. Maximum VOC Concentrations over Time at Shallow Soil-Gas Probe SG N-9

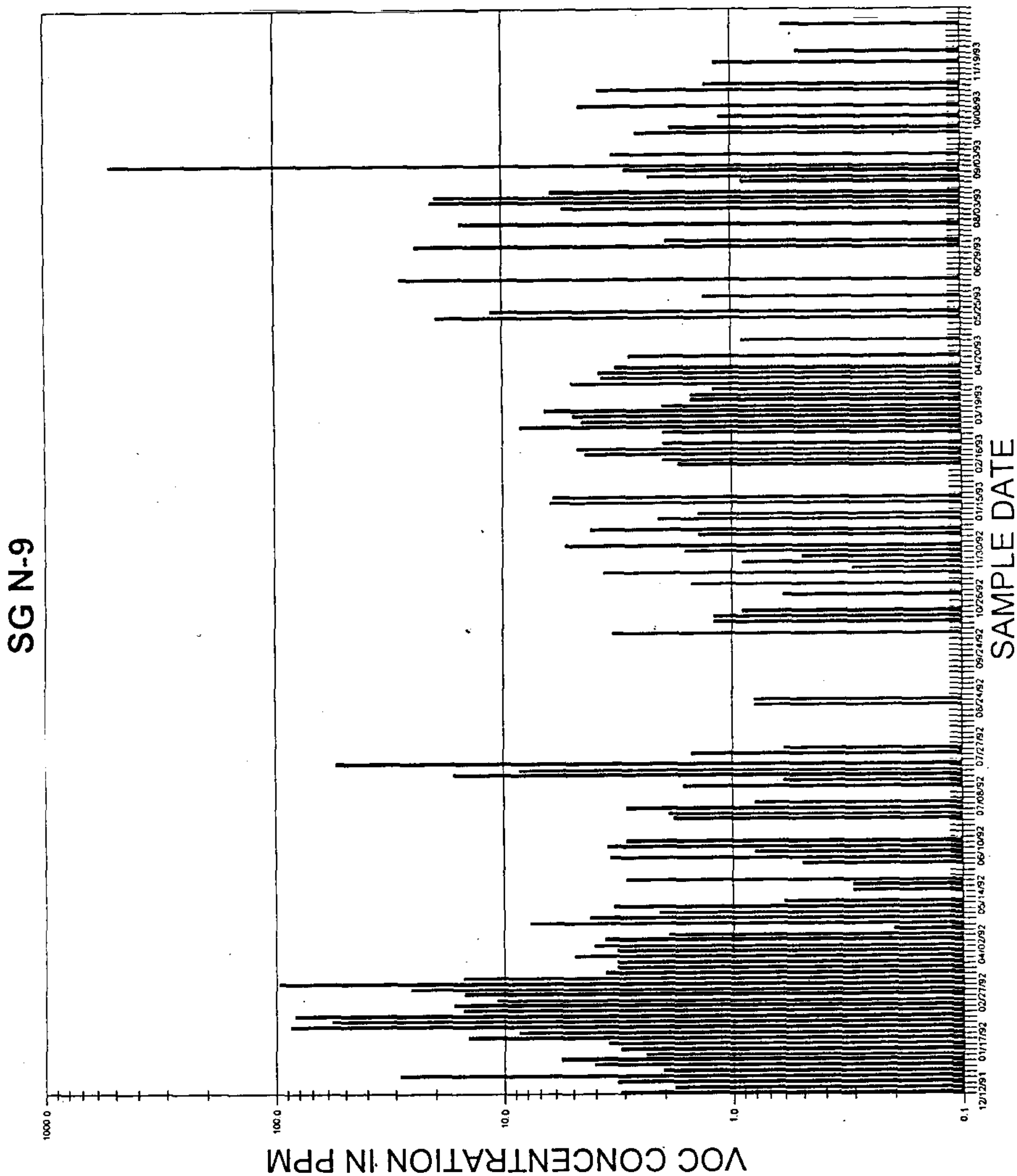


Figure 4-8. Shallow Soil-Gas Probe Detections

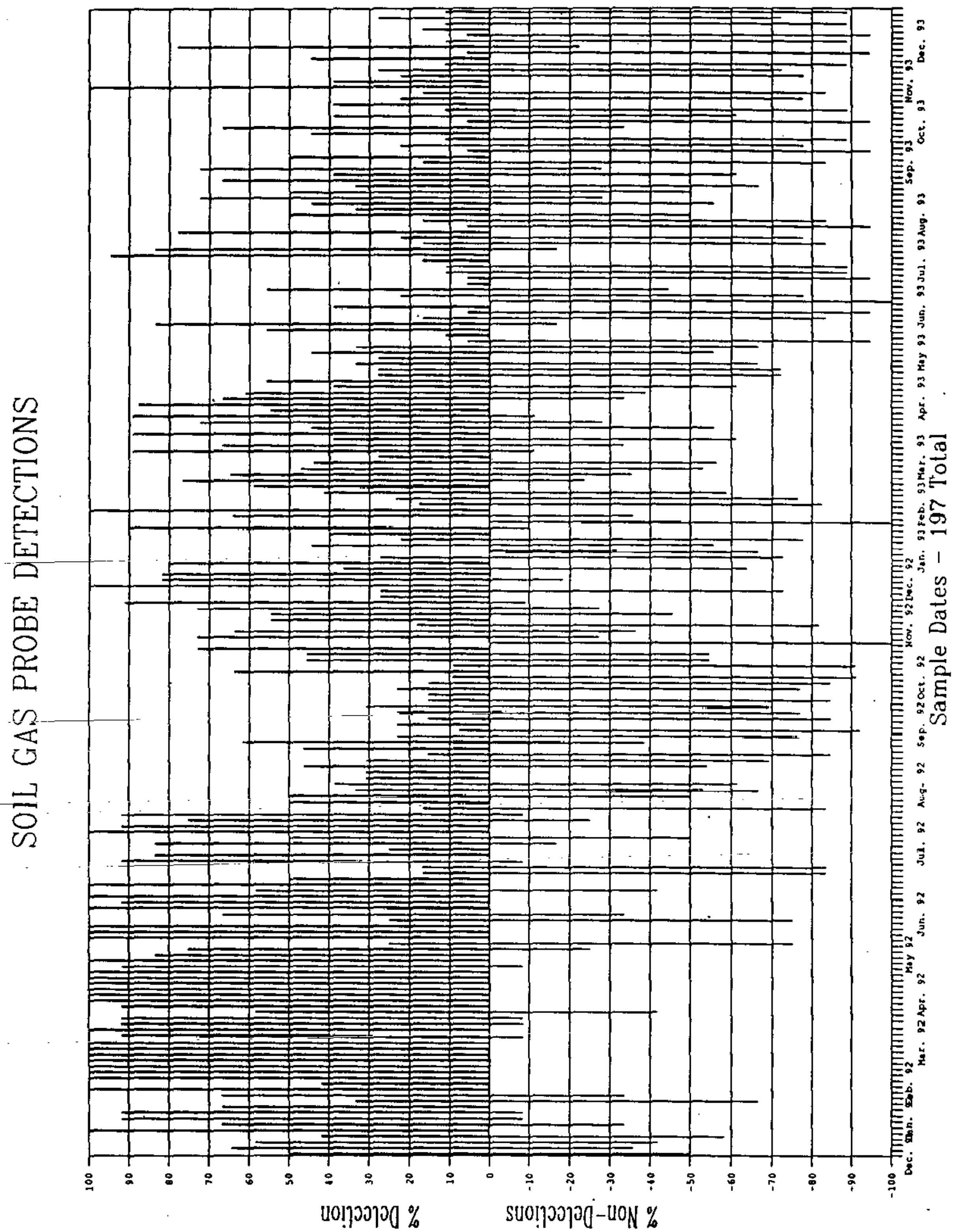


Figure 4-9. Maximum VOC Concentrations over Time
at Deep Soil-Gas Probe CPT-15-6

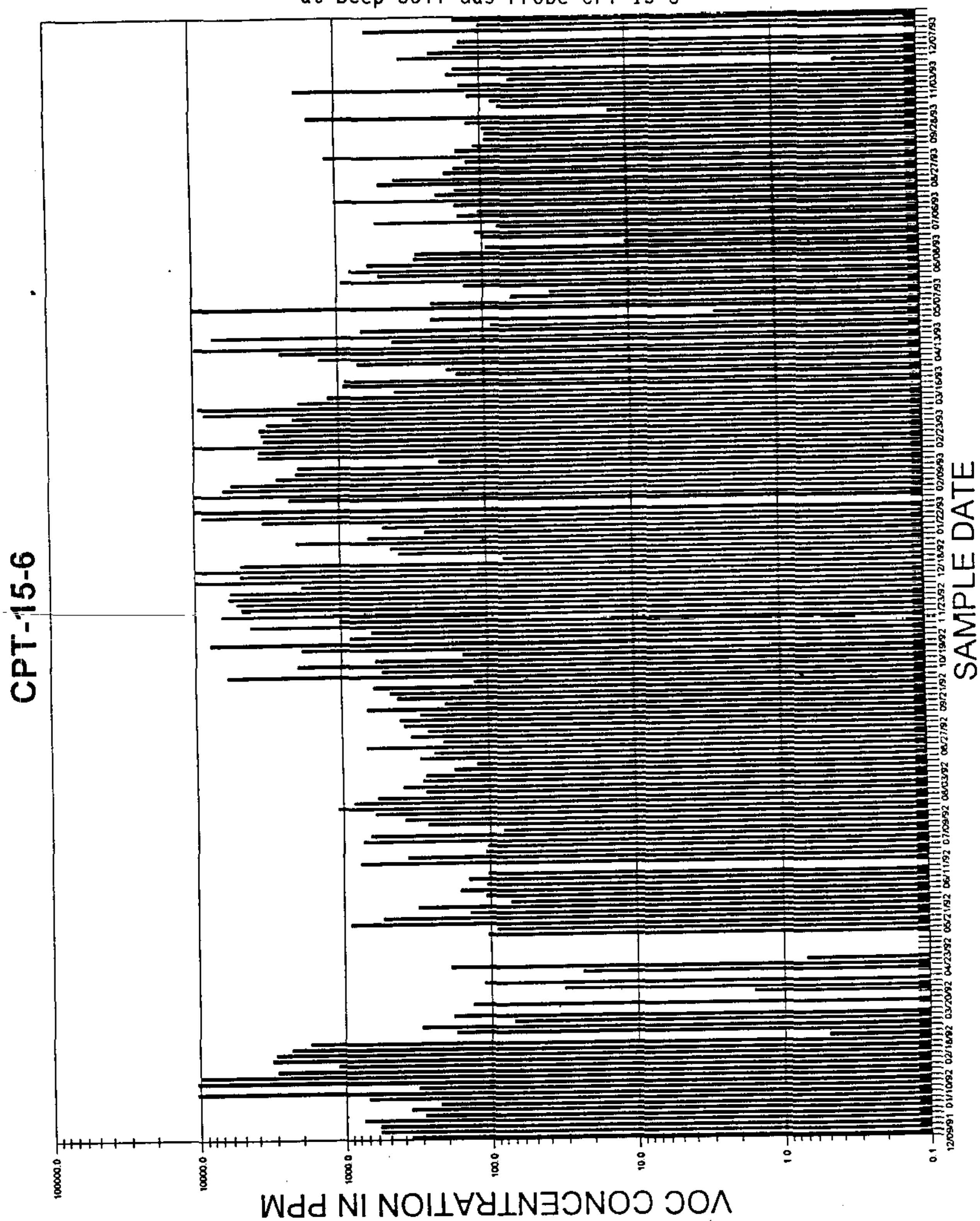
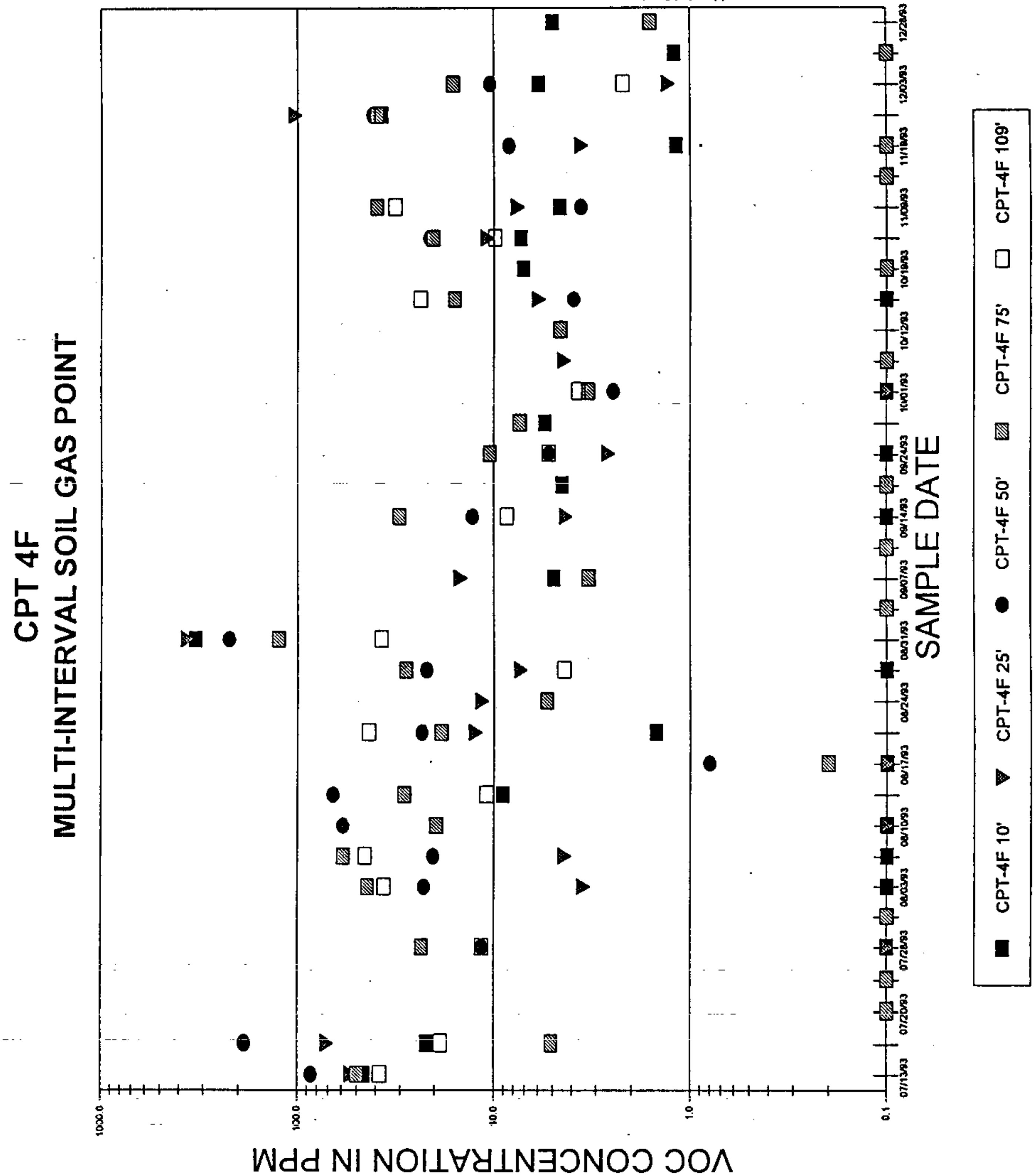


Figure 4-10. Maximum VOC Concentrations over Time at Multi-Level Soil-Gas Probe CPT-4F



4.5 COMPARING SOIL-GAS AND WELLHEAD CONCENTRATIONS

Concentrations of VOCs detected in shallow soil-gas probes in most cases are lower than levels detected in deep soil-gas probes or wellheads. The highest shallow probe value detected was 132 ppmv while the highest wellhead value detected was over 10,000 ppmv. One of the 3 deep soil-gas probes recorded high (>10,000 ppmv) VOC concentrations. Figure 4-11 compares VOC concentrations from a wellhead and nearby deep soil-gas probe. In nearly all cases the deep soil-gas probe had higher concentrations.

Figure 4-12 shows VOC concentrations from the same wellhead and deep soil-gas probe compared with VOC concentrations in a nearby shallow soil-gas probe. Again the deep soil-gas probe had highest concentrations, but the shallow soil-gas probe occasionally had higher VOC concentrations than the wellhead. Because of various emplacement depths and differing emplacement locations, additional comparisons between soil-gas and wellhead VOC concentrations are difficult.

Figure 4-11. VOC Concentrations at Well 299-W15-216
and Deep Soil-Gas Probe SG 15-6

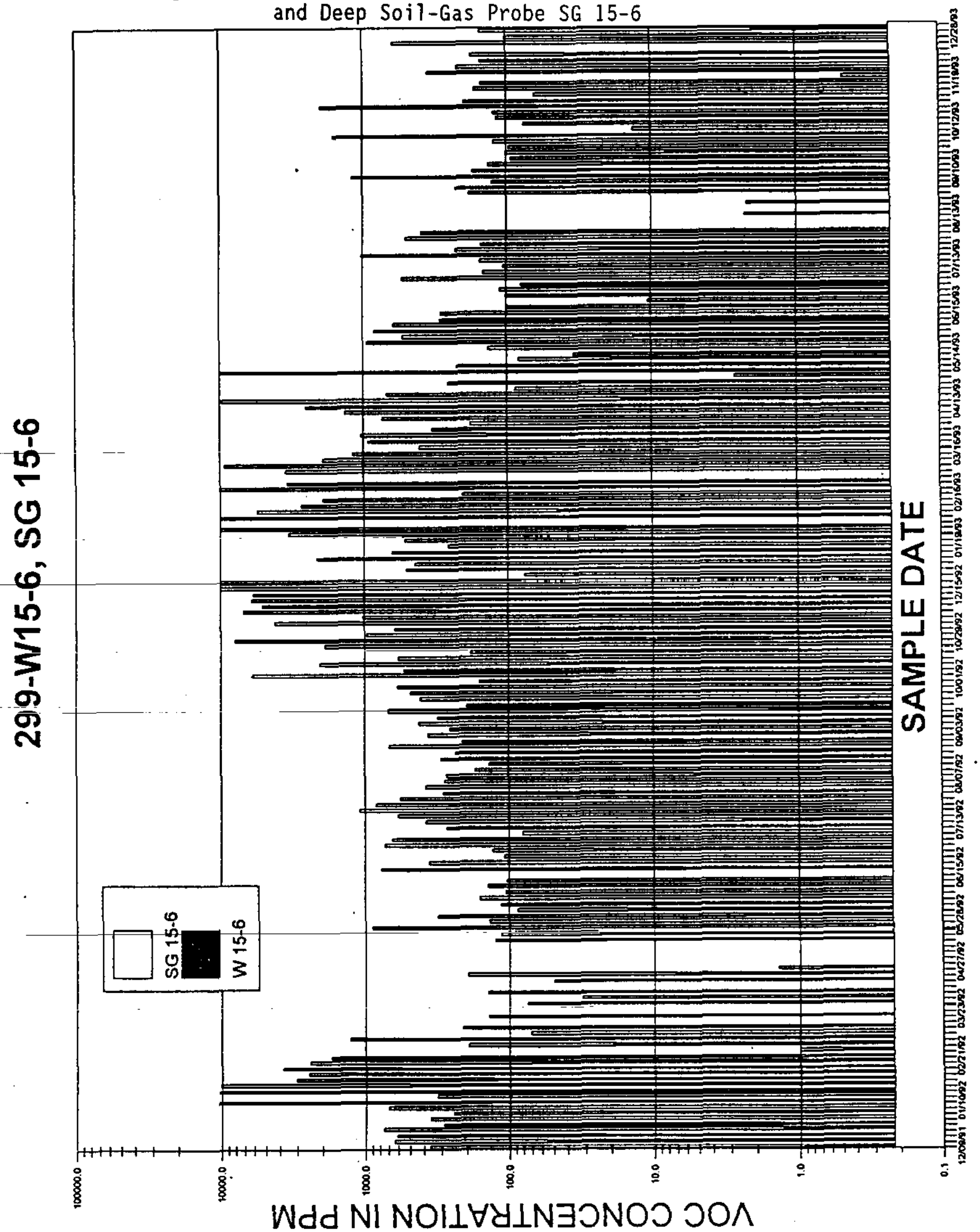
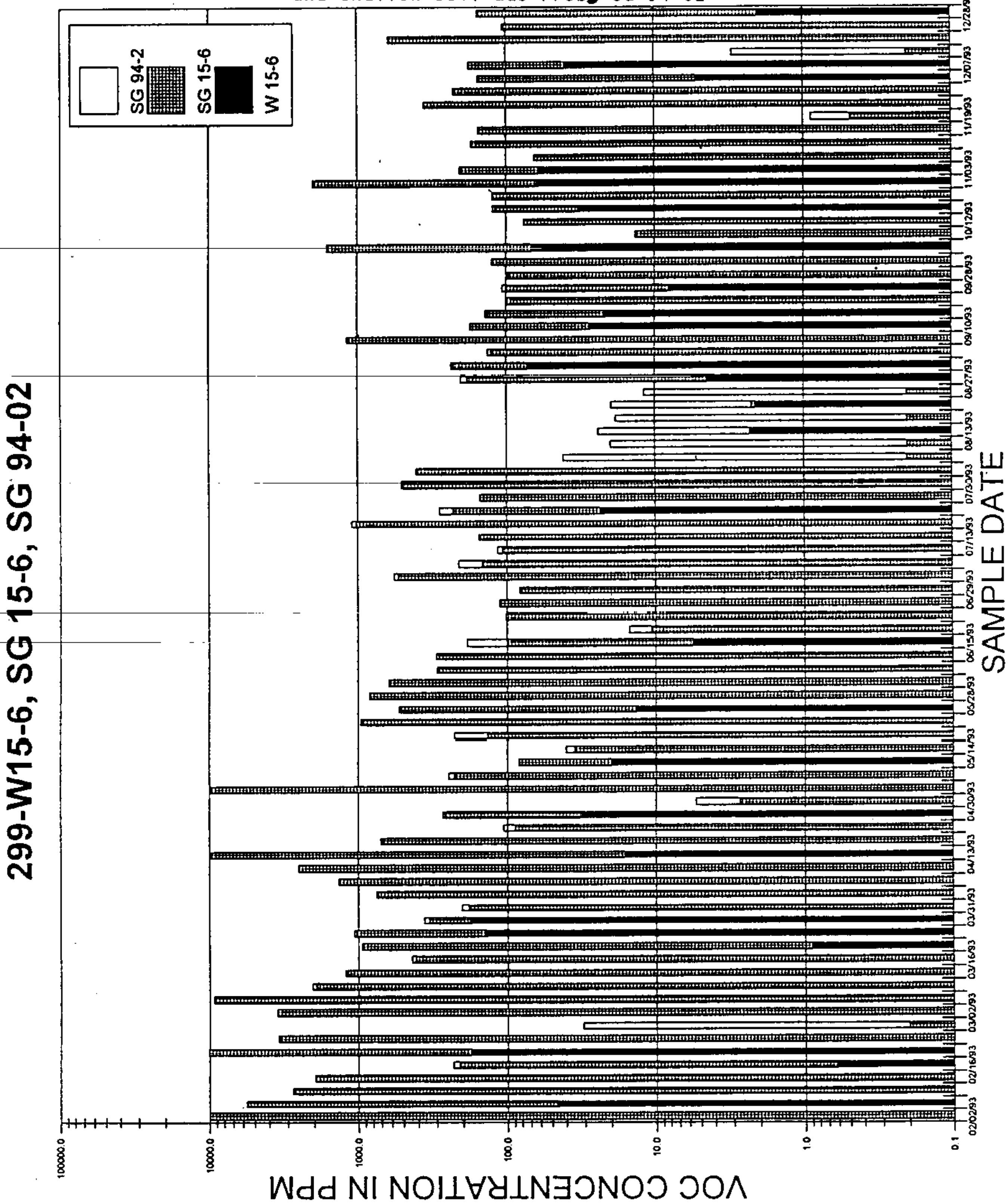


Figure 4-12. VOC Concentrations at Well 299-W15-216, Deep Soil-Gas Probe SG 15-6, and Shallow Soil-Gas Probe SG 94-02



5.0 NONROUTINE FARFIELD MONITORING

During FY 1993, as time allowed, other wells in the 200 West Area were also monitored for VOCs. This additional monitoring was performed when the two following criteria were met: barometric pressure was at or below 29.0 in. of Hg., and sampling personnel were available. Routine sampling occupied two days of the five-day work week, so samplers were not always available on an on-call basis. A total of 111 wells were monitored on a one-time basis.

Health and safety monitoring data were also collected farfield by well maintenance crews. Much of these data provided additional information about wells that were routinely used to take water samples, perform geophysical logging, and take water level measurements. New information about VOC emissions from a few previously unmonitored wells was provided.

Table 5-1 lists single point detections from farfield monitoring and health and safety monitoring. Appendix D presents a table listing all wells sampled during nonroutine farfield monitoring. Figure 5-1 shows nonroutine farfield wells monitored and indicates whether VOCs were detected. VOCs were detected in areas outside the original baseline monitoring area including:

- Southeast of U Tank Farm
- East of Crib 216-Z-7.

Figure 5-1. Nonroutine Farfield Monitoring Wells and VOC Detections

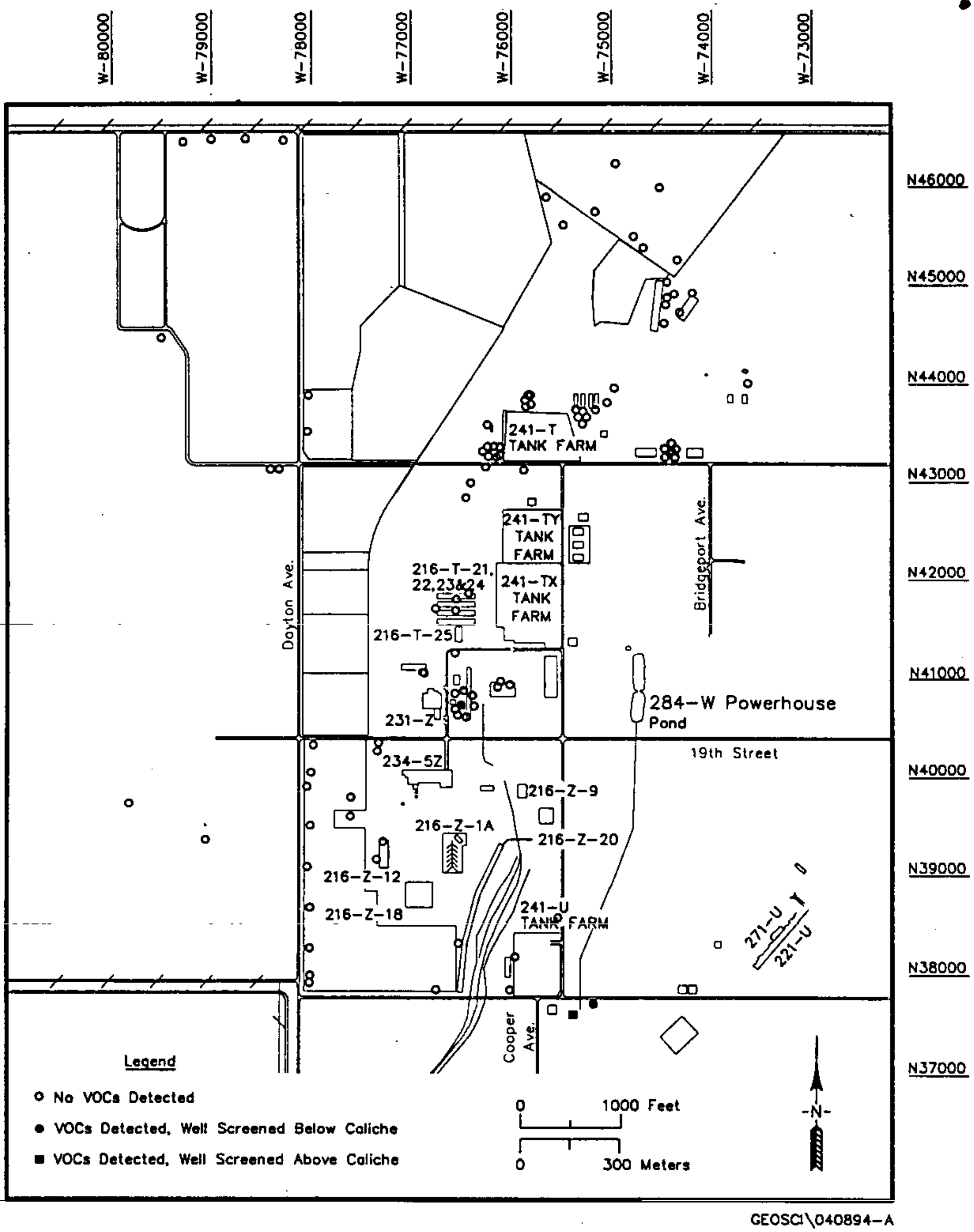


Table 5-1. Nonroutine Farfield VOC Detections

Well Number	Maximum ppmv	Depth (ft) Top of Open Interval	Area
299-W15-1	11	190	E of 216-Z-7 Crib
299-W19-27	17	208	SE of U Tank Farm
299-W19-91	13	110	SE of U Tank Farm; only well open above caliche

6.0 SEALED WELL TESTS

On four occasions, wells in the monitoring network were tested to estimate the relative amount of air inflow or outflow. After the well cap was removed, a small plastic bag was placed over the wellhead. This bag was tightly sealed by constricting the bag to the outer casing surface. A subjective measurement of airflow (high/medium/low) into or out of the well was then noted, based on how quickly the bag was either filled with or evacuated of air. Wells with air flowing into the well were noted as negative, while wells with air flowing out were recorded as positive.

Figures 6-1, 6-2, 6-3, and 6-4 depict the sealed well tests. The most interesting test was conducted April 13 (Figure 6-1). On this date, a change occurred in subsurface pressure; the upper vadose zone above the caliche layer had lower pressure than the atmospheric pressure, so air was flowing into most of these wells. Pressure in wells below the caliche layer, on the other hand, was mainly positive, causing vapors to exit the wellhead.

During testing on August 3 and December 3, 1993, air in all wells was observed to be either venting from wells or neutral (neither venting from nor moving into wells). During the test on December 28, 1993, air in all wells was either moving into wells or neutral.

Figure 6-1. Sealed Well Test April 13, 1993

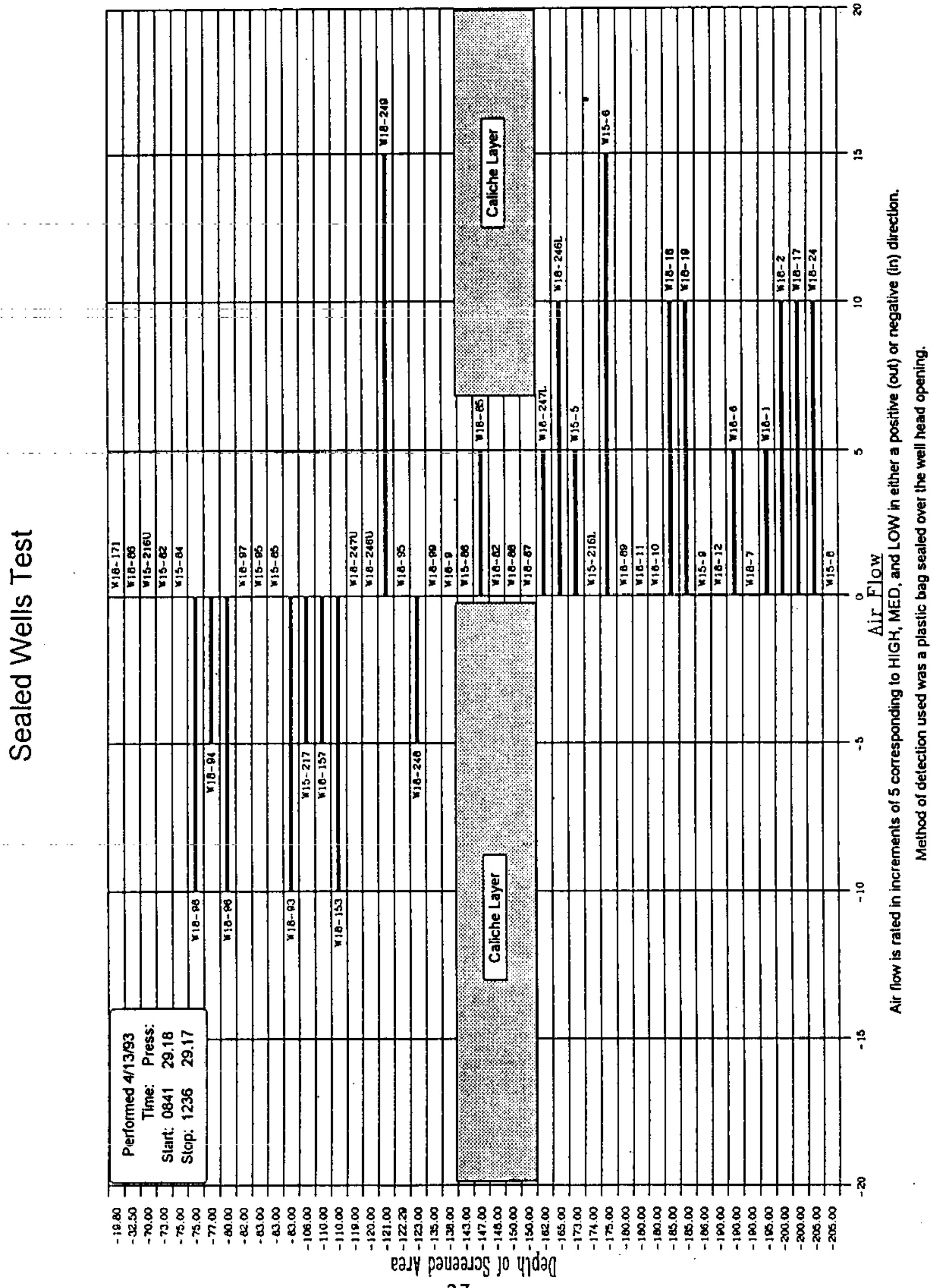


Figure 6-2. Sealed Well Test August 3, 1993

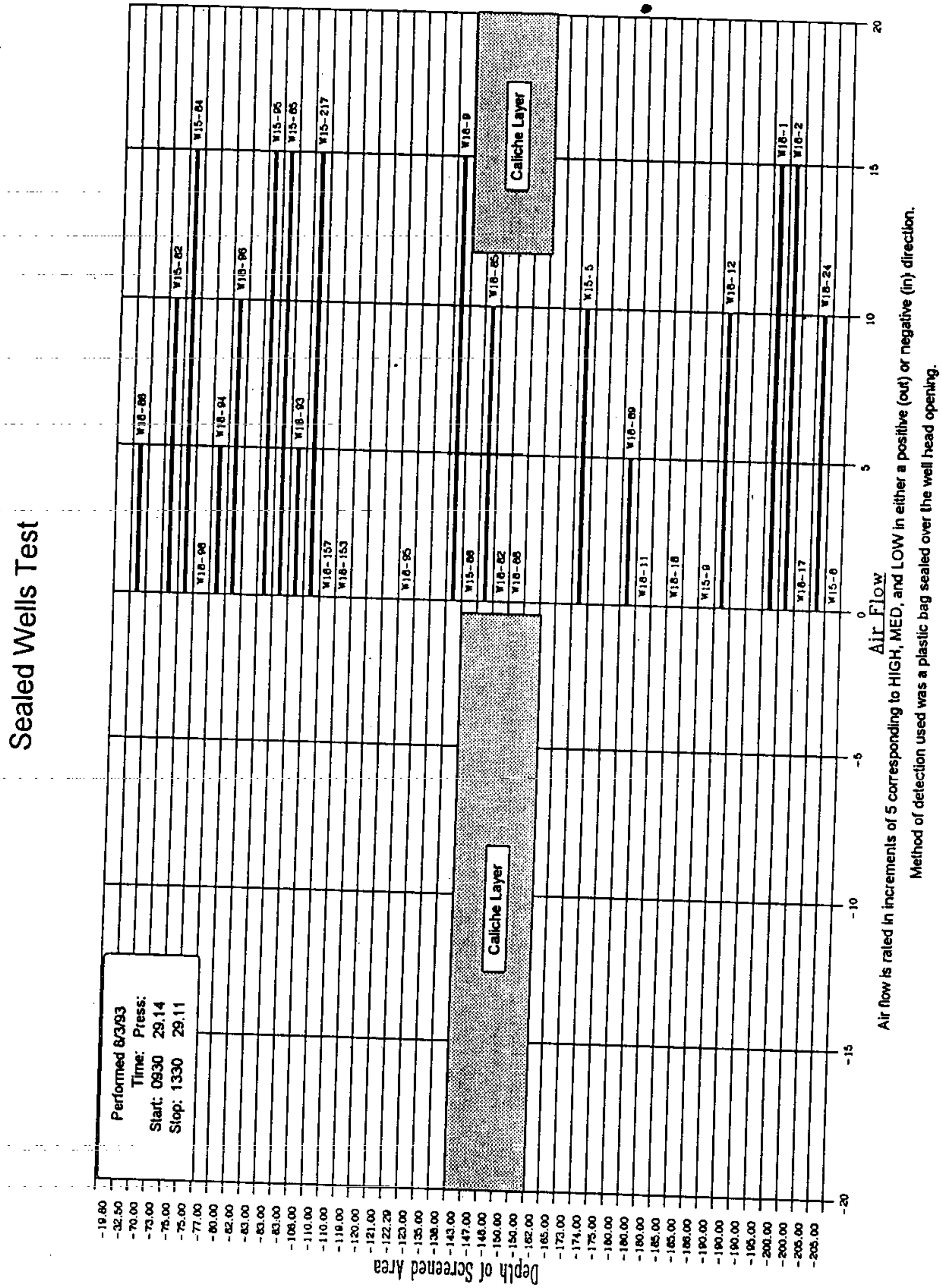
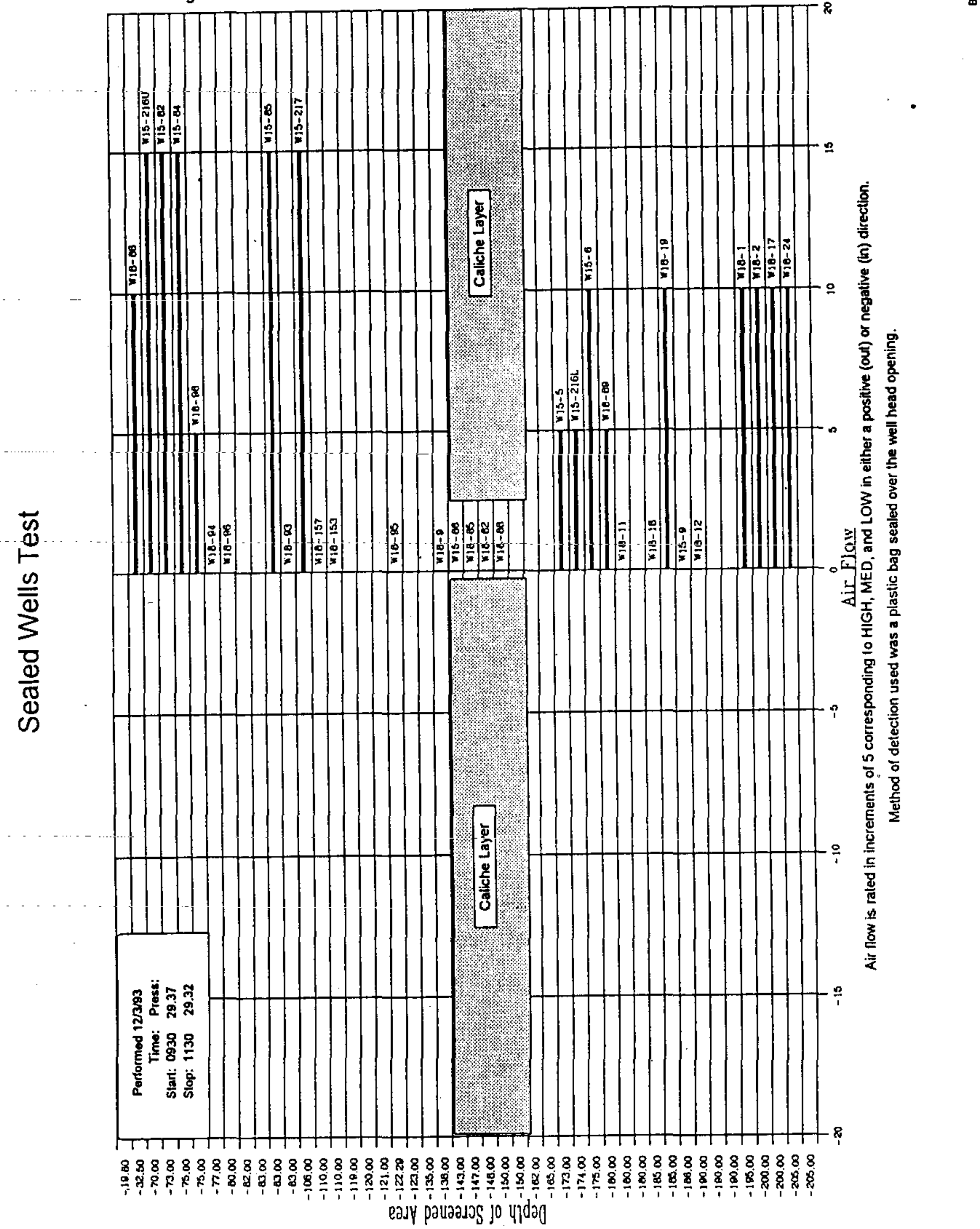


Figure 6-3. Sealed Well Test December 3, 1993



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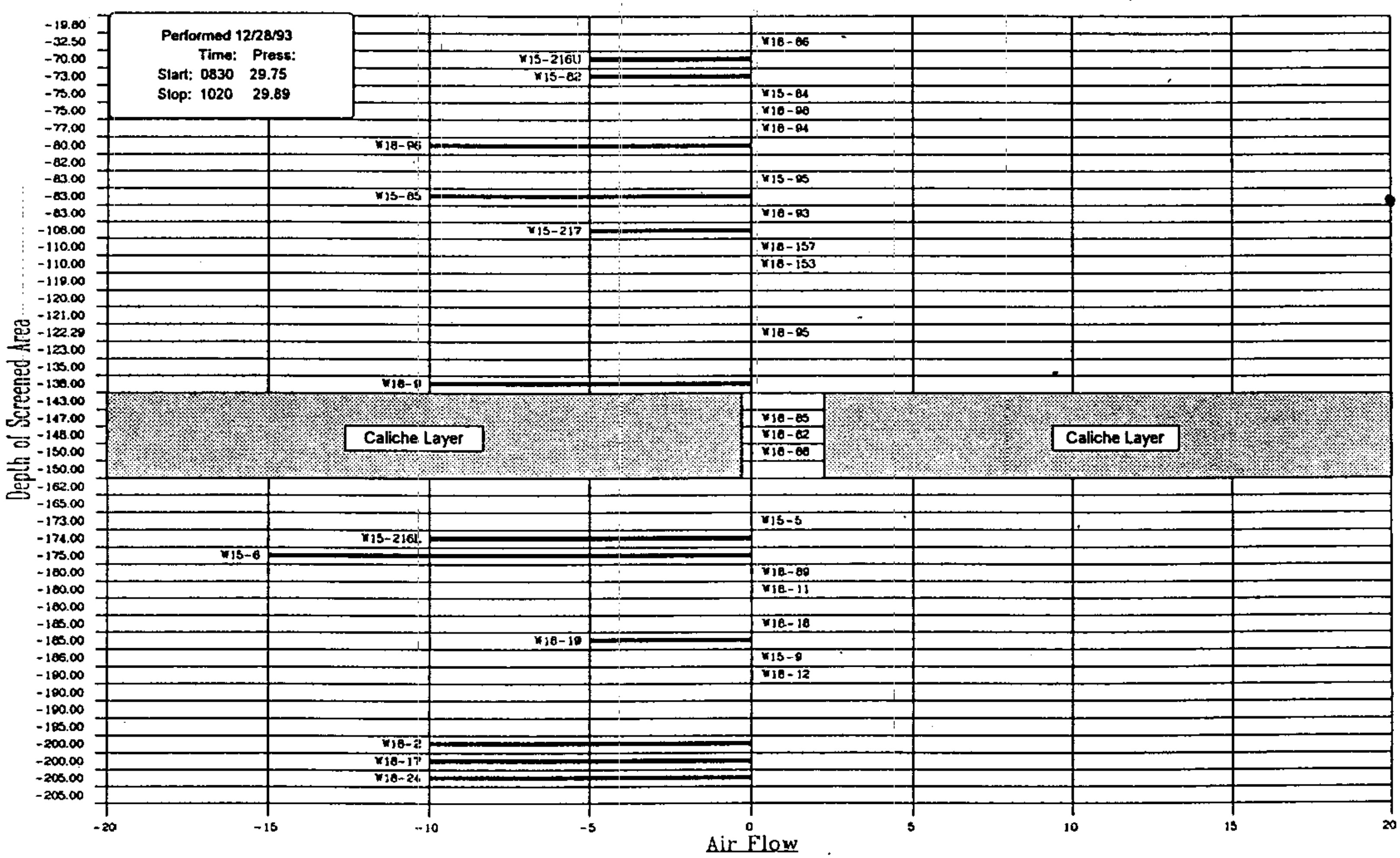
Sealed Wells Test



Air flow is rated in increments of 5 corresponding to HIGH, MED, and LOW in either a positive (out) or negative (in) direction.
Method of detection used was a plastic bag sealed over the well head opening.

Figure 6-4. Sealed Well Test December 28, 1993

BLDATA.WQ1

7.0 CONCLUSIONS

Concentrations of VOCs were highest at the 216-Z-9 Trench, where measurements exceeding 10,000 ppmv were taken on several occasions. VOCs were also detected during routine monitoring at the 216-Z-1A Tile Field and the 216-Z-18 Crib, where maximum concentrations were 1,532 and 442 ppmv, respectively.

During monitoring near the 216-Z-12 Crib, significant quantities of VOCs were detected in wellheads and soil-gas probes. The highest wellhead reading was 1,672 ppmv, and the highest soil-gas reading was 132 ppmv. Both of these measurements were taken east of the 216-Z-12 Crib. Previous reports (DOE 1991) indicate small quantities of VOCs were disposed of to the crib. The source of these VOCs should be investigated.

Concentrations of VOCs are higher in wells with subsurface openings (perforations or screen) above the semi-confining caliche horizon. Distance between a well and the waste disposal area also affects VOC levels detected in wellheads. Wells located very near waste sites generally have higher levels than wells farther away. Wells with subsurface openings perforated or screened in or just above the groundwater have higher VOC levels than those with openings also below the caliche but significantly above the groundwater.

Two seasonal trends are apparent as indicated by graphs of wellhead and soil-gas probe concentrations. VOC concentrations in wellheads and deep soil-gas probes are generally higher in the fall and winter months. VOC detections from shallow soil-gas probes show an apparent seasonality of more detections during winter, spring, and early summer.

An array of multi-level soil-gas points was emplaced between the 216-Z-1A Tile Field and the 216-Z-12 Crib in mid-1993. These points were monitored until the end of 1993. Significant quantities of VOCs were detected in all points. The highest level detected was 1,251 ppmv. These results indicate that a broad plume likely exists between these two waste disposal sites.

Additional wellhead monitoring farther from the carbon tetrachloride disposal sites detected VOCs in single point and multiple point detections. Many of these detections occurred at other waste disposal sites. These anomalies should be investigated to determine the source of the VOCs.

This report is being provided to WHC safety, well maintenance, subsurface geophysics, and groundwater sampling groups. These data may be useful in planning work at wells where VOCs have been detected.

A solid baseline of VOC concentrations in wells and soil-gas at the ERA site has been established. As site remediation continues, comparisons to this baseline can be one means of measuring the success of vapor extraction and other site remediation methods.

8.0 REFERENCES

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APPENDIX A

BASELINE MONITORING STATISTICS - DECEMBER 1991 THROUGH DECEMBER 1993

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
CPT 15-6	10400.0	0.0	1534.41	1613.10	205	195
CPT 15-84	259.0	0.0	17.72	28.65	131	81
CPT PNL-5	12.4	0.0	0.74	4.75	58	9
CPT-4B 5'	1093.4	0.0	39.23	78.45	38	19
CPT-4B 25'	137.8	0.0	17.02	20.86	38	31
CPT-4B 50'	216.8	0.0	19.20	26.75	39	28
CPT-4B 75'	73.6	0.0	12.54	14.89	38	32
CPT-4B 90'	485.6	0.0	41.72	54.67	38	29
CPT-4C 10'	1058.6	0.0	33.28	54.98	38	23
CPT-4C 25'	81.2	0.0	10.47	13.26	38	30
CPT-4C 50'	144.6	0.0	23.85	29.23	38	31
CPT-4C 75'	1251.6	0.0	72.13	94.52	38	29
CPT-4C 107'	479.2	0.0	46.56	68.05	38	26
CPT-4D 10'	28.6	0.0	5.42	10.06	13	7
CPT-4D 25'	28.6	0.0	6.70	7.92	13	11
CPT-4D 40'	28.6	0.0	8.46	11.00	13	10
CPT-4D 75'	61.0	0.0	14.97	19.46	13	10
CPT-4D 99'	49.0	0.0	14.68	21.20	13	9
CPT-4E 10'	448.0	0.0	14.85	33.19	38	17
CPT-4E 25'	60.4	0.0	6.96	10.17	38	26
CPT-4E 75'	515.8	0.0	28.49	38.66	38	28
CPT-4E 103'	135.6	0.0	17.26	24.30	38	27
CPT-4F 10'	333.4	0.0	14.47	28.13	35	18
CPT-4F 25'	365.0	0.0	20.96	31.89	35	23
CPT-4F 50'	224.0	0.0	24.54	33.03	35	26
CPT-4F 75'	125.6	0.0	17.11	24.95	35	24
CPT-4F 109'	45.6	0.0	11.19	17.80	35	22
CPT-4G 100'	186.8	0.0	37.21	44.19	38	32
CPT-4H 75'	396.2	0.0	51.37	59.15	38	33

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
CPT-4J 25'	25.6	0.0	5.08	7.43	38	26
CPT-4L 50'	156.8	0.0	20.36	24.96	38	31
SG 86-4	62.9	0.0	7.03	12.34	86	49
SG 86-5	67.9	0.0	3.44	8.00	86	37
SG 86-6	307.0	0.0	4.63	24.59	85	16
SG 94-2	132.0	0.0	19.53	24.06	85	69
SG 94-4	71.2	0.0	10.10	11.45	85	75
SG 94-5	19.0	0.0	1.35	8.08	84	14
SG 94-7	22.2	0.0	1.18	6.28	85	16
SG C-1	20.6	0.0	2.10	4.58	198	91
SG E-2	407.0	0.0	12.78	27.95	199	91
SG E-3	17.5	0.0	1.22	3.90	195	61
SG N-1	4.8	0.3	2.55	2.55	2	2
SG N-2	112.8	0.0	2.52	5.74	196	86
SG N-3	95.0	0.0	2.80	5.11	188	103
SG N-5	204.8	0.0	2.50	6.58	200	76
SG N-6	1249.6	0.0	7.44	24.89	194	58
SG N-7	134.6	0.0	4.15	7.21	200	115
SG N-8	10.0	10.0	10.00	10.00	1	1
SG N-9	517.2	0.0	7.37	12.12	199	121
SG S-1	0.6	0.6	0.60	0.60	1	1
SG W-1	291.2	0.0	2.92	7.27	197	79
SG W-3	2.4	2.4	2.40	2.40	1	1
SG W-5	50.2	0.0	2.93	4.66	194	122
W 10-9	3.9	0.0	0.08	2.10	84	3
W 10-15	0.1	0.0	0.00	0.10	84	1
W 10-16	0.0	0.0	0.00	0.00	84	0
W 10-17	0.2	0.0	0.00	0.20	84	1
W 10-18	0.2	0.0	0.00	0.20	83	1

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
W 10-71	0.0	0.0	0.00	0.00	78	0
W 10-81	0.0	0.0	0.00	0.00	78	0
W 11-1	2.3	0.0	0.04	1.23	84	3
W 11-27	0.1	0.0	0.00	0.10	84	1
W 11-28	0.1	0.0	0.00	0.10	83	1
W 14-12	3.8	0.0	0.06	2.57	84	2
W 14-51	0.1	0.0	0.00	0.10	83	1
W 15-4	49.8	0.0	1.76	8.30	80	17
W 15-5	401.0	0.0	14.33	39.08	150	55
W 15-6	1367.0	0.0	34.86	77.51	189	85
W 15-8	14.0	0.0	0.16	2.57	143	9
W 15-9	199.6	0.0	11.81	38.07	158	49
W 15-12	4.3	0.0	0.08	2.26	84	3
W 15-13	0.2	0.0	0.00	0.20	83	1
W 15-22	9.6	0.0	0.18	3.79	85	4
W 15-64	0.1	0.0	0.00	0.10	83	1
W 15-66	0.6	0.0	0.01	0.35	83	2
W 15-76	2.3	0.0	0.04	1.00	83	3
W 15-82	10000.0	0.0	383.96	651.07	195	115
W 15-84	1295.0	0.0	26.95	91.92	191	56
W 15-85	5737.0	0.0	142.12	349.84	160	65
W 15-86	21.8	0.0	0.23	2.56	144	13
W 15-95	10704.0	0.0	206.52	440.41	177	83
W 15-216	1271.0	0.0	40.18	123.06	49	16
W 15-216 Lower Interval	588.0	0.0	39.68	105.23	61	23
W 15-216 Upper Interval	621.0	0.0	42.09	142.62	61	18
W 15-217	3997.0	0.0	127.83	349.86	104	38
W 15-218	479.6	0.0	68.56	137.12	28	14
W 15-218 Lower Interval	212.6	0.0	22.79	72.92	16	5

9413290.1123

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
W 15-218 Upper Interval	170.6	0.0	20.52	46.91	16	7
W 15-219 Lower Interval	31.8	0.0	3.48	26.10	15	2
W 15-219 Upper Interval	204.5	0.0	29.55	88.66	15	5
W 15-220 Lower Interval	114.8	0.0	16.99	63.70	15	4
W 15-220 Upper Interval	124.0	0.0	15.95	59.83	15	4
W 18-1	1018.0	0.0	16.58	42.23	191	75
W 18-2	806.0	0.0	22.24	47.72	191	89
W 18-5	0.0	0.0	0.00	0.00	2	0
W 18-6	1073.0	0.0	23.97	52.52	184	84
W 18-7	474.0	0.0	11.97	30.52	181	71
W 18-9	259.0	0.0	6.75	20.14	194	65
W 18-10	442.0	0.0	33.28	57.06	36	21
W 18-11	188.4	0.0	4.32	13.53	194	62
W 18-12	199.0	0.0	5.60	18.45	191	58
W 18-17	135.0	0.0	4.47	16.35	183	50
W 18-18	28.2	0.0	0.70	4.06	180	31
W 18-19	22.8	0.0	0.48	4.15	180	21
W 18-24	336.0	0.0	6.79	18.90	192	69
W 18-29	11.4	0.0	0.19	5.49	87	3
W 18-30	1.7	0.0	0.85	1.70	2	1
W 18-82	12.0	0.0	0.35	2.19	196	31
W 18-85	238.5	0.0	11.60	26.23	199	88
W 18-86	170.0	0.0	7.90	22.98	195	67
W 18-87	70.0	0.0	2.93	8.74	209	70
W 18-88	5.3	0.0	0.13	1.07	194	23
W 18-89	212.0	0.0	3.30	13.98	195	46
W 18-93	114.0	0.0	1.38	9.93	194	27
W 18-94	117.7	0.0	2.04	12.93	196	31
W 18-95	169.4	0.0	4.34	21.15	195	40

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
W 18-96	246.5	0.0	8.62	34.11	186	47
W 18-97	17.5	0.0	3.56	6.18	33	19
W 18-98	39.0	0.0	1.22	4.90	184	46
W 18-99	56.0	0.0	0.63	3.37	171	32
W 18-152	119.6	0.0	7.36	19.04	88	34
W 18-153	1671.5	0.0	28.07	82.47	191	65
W 18-155	0.0	0.0	0.00	0.00	64	0
W 18-157	696.5	0.0	8.24	30.84	191	51
W 18-171	140.5	0.0	3.82	12.69	209	63
W 18-246	498.0	0.0	60.06	110.63	35	19
W 18-246 Lower Interval	450.0	0.0	21.20	43.71	101	49
W 18-246 Upper Interval	382.0	0.0	10.45	29.77	94	33
W 18-247	180.0	0.0	8.78	23.04	63	24
W 18-247 Lower Interval	114.0	0.0	10.14	38.01	60	16
W 18-247 Upper Interval	47.0	0.0	4.64	12.31	61	23
W 18-248	1532.0	0.0	23.76	107.70	136	30
W 18-249	120.0	0.0	9.34	19.41	133	64
VR-1 at Z-18	0.0	0.0	0.00	0.00	4	0
VR-2 at Z-18	1.8	0.0	0.45	1.80	4	1
VR-3 at Z-18	0.0	0.0	0.00	0.00	4	0
VR-4 at Z-18	0.0	0.0	0.00	0.00	4	0
VR-5 at Z-18	0.5	0.0	0.13	0.51	4	1
DAYTON & 16TH	0.0	0.0	0.00	0.00	1	0
FENCELINE S OF Z1A CRIB	0.3	0.3	0.30	0.30	1	1
NE FENCE CORNER	0.0	0.0	0.00	0.00	1	0
NE PERIMETER	0.0	0.0	0.00	0.00	1	0
NW FENCE CORNER	0.0	0.0	0.00	0.00	1	0
NW PERIMETER	0.0	0.0	0.00	0.00	1	0
S OF Z-9	0.0	0.0	0.00	0.00	1	0

SAMPLE POINT	MAXIMUM (all points)	MINIMUM (all points)	AVERAGE (all points)	AVERAGE (all positive points)	# SAMPLES (all points)	# SAMPLES (all positive points)
SE FENCE CORNER	0.4	0.4	0.37	0.37	1	1
SE PERIMETER	0.0	0.0	0.00	0.00	1	0
SW FENCE CORNER	0.0	0.0	0.00	0.00	1	0
SW PERIMETER	0.3	0.3	0.30	0.30	1	1
Z18 CRIB BETW V-R 1 & 2	0.0	0.0	0.00	0.00	1	0

APPENDIX B

WELL CONSTRUCTION DATA

WELL No.	INT. No.	WELL TYPE	CASE SIZE	CASE TYPE*	DEPTH TO WATER	DEPTH TO BOT.	SCREEN OPEN AREA (OA) INFORMATION: FEET BELOW TOP OF CASING TOP	FEET BELOW TOP OF CASING BOT.	TOTAL LENGTH (FT.)	*COR. LENGTH (FT.)	Sq.in/ft OPEN AREA	TOTAL SCREEN OA	PERFORATION OPEN AREA (OA) INFORMATION: FEET BELOW TOP OF CASING TOP	FEET BELOW TOP OF CASING BOT.	TOTAL LENGTH (FT.)	*COR. LENGTH (FT.)	PERF. PER FOOT	Sq.in/ft OPEN AREA	TOTAL PERF. OA	BOTTOM INFORMATION: STATUS	CASE I.D.	TOTAL BOT. OA	TOTALS: INT. OA (sq.in.)	WELL OA (sq.in.)
W10-9	1	WATER	6-in	CS	214.12	225.00	202.00		18.00	12.12	53.00	642.36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SUB.	4.88	0.00	642.36	642.36
W10-15	1	WATER	4-in	SS	214.95	222.00	201.00	222.00	21.00	13.95	26.00	362.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	362.70	362.70
W10-16	1	WATER	4-in	SS	211.61	219.30	198.30	219.30	21.00	13.31	26.00	346.06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	346.06	346.06
W10-17	1	WATER	4-in	SS	209.42	222.70	201.40	222.70	21.30	8.02	26.00	208.52	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	208.52	208.52
W10-18	1	WATER	4-in	SS	208.61	221.10	199.80	221.10	21.30	8.81	26.00	229.06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	229.06	229.06
W11-1	1	WATER	8-in	CS	250.00	314.50	N/A	N/A	N/A	N/A	N/A	N/A	220.00	260.00	40.00	30.00	3.00	0.42	12.60	SUB.	8.00	0.00	12.60	12.60
	2	WATER	8-in	CS	250.00	314.50	N/A	N/A	N/A	N/A	N/A	N/A	270.00	311.00	41.00	0.00	5.00	0.70	0.00	N/A	N/A	0.00	0.00	N/A
W11-27	1	WATER	4-in	SS	224.67	233.60	213.20	233.60	20.40	11.47	26.00	298.22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	298.22	298.22
W11-28	1	WATER	4-in	SS	232.25	244.90	224.00	244.90	20.90	8.25	26.00	214.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	214.50	214.50
W14-12	1	WATER	4-in	SS	207.39	218.70	198.40	218.70	20.30	8.99	26.00	233.74	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	233.74	233.74
W14-51	1	VAD.	6-in	CS	N/A	75.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	0.00	0.00
W15-4	1	WATER	8-in	CS	200.07	217.00	N/A	N/A	N/A	N/A	N/A	N/A	170.00	216.00	46.00	30.00	2.00	0.28	8.40	SUB.	8.00	0.00	8.40	8.40
W15-5	1	WATER	8-in	CS	203.46	340.00	N/A	N/A	N/A	N/A	N/A	N/A	173.00	217.00	44.00	30.46	1.00	0.14	4.26	SUB.	8.00	0.00	4.26	4.26
	2	WATER	8-in	CS	203.46	340.00	N/A	N/A	N/A	N/A	N/A	N/A	480.00	524.00	123.00	0.00	4.00	0.56	0.00	N/A	N/A	0.00	0.00	N/A
W15-6	1	WATER	8-in	CS	190.00	410.00	N/A	N/A	N/A	N/A	N/A	N/A	175.00	300.00	125.00	12.00	2.00	0.28	3.36	SUB.	8.00	0.00	3.36	3.36
	2	WATER	6-in	CS	190.00	410.00	N/A	N/A	N/A	N/A	N/A	N/A	307.00	408.00	101.00	0.00	2.00	0.28	0.00	N/A	N/A	0.00	0.00	N/A
W15-8	1	WATER	8-in	CS	196.00	205.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	0.00	0.00
W15-9	1	WATER	4-in	SS	190.00	194.00	N/A	N/A	N/A	N/A	N/A	N/A	186.00	189.00	3.00	3.00	2.00	0.28	0.84	SUB.	6.00	0.00	0.84	0.84
W15-12	1	WATER	6-in	CS	207.64	225.00	N/A	N/A	N/A	N/A	N/A	N/A	195.00	215.00	20.00	12.64	4.00	0.56	7.08	CLOSED	N/A	0.00	7.08	7.08
W15-13	1	WATER	6-in	CS	207.64	225.00	N/A	N/A	N/A	N/A	N/A	N/A	197.00	205.00	8.00	8.00	2.00	0.28	2.24	CLOSED	N/A	0.00	2.24	3.35
	2	WATER	6-in	CS	207.64	225.00	N/A	N/A	N/A	N/A	N/A	N/A	205.00	225.00	20.00	2.64	3.00	0.42	1.11	CLOSED	N/A	0.00	1.11	N/A
W15-22	1	WATER	4-in	SS	206.46	219.80	198.50	219.80	21.30	7.96	26.00	206.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	206.96	206.96
W15-64	1	VAD.	8-in	CS	N/A	189.00	N/A	N/A	N/A	N/A	N/A	N/A	0.00	150.00	150.00	150.00	2.00	0.28	42.00	CLOSED	N/A	0.00	42.00	42.00
W15-66	1	VAD.	8-in	CS	N/A	73.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	0.00	0.00
W15-76	1	VAD.	8-in	CS	N/A	103.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	8.00	50.27	50.27	50.27
W15-82	1	VAD.	8-in	CS	N/A	101.58	N/A	N/A	N/A	N/A	N/A	N/A	73.00	88.00	15.00	15.00	24.00	3.36	50.40	OPEN	8.00	50.27	100.67	100.67
W15-84	1	VAD.	8-in	CS	N/A	107.78	N/A	N/A	N/A	N/A	N/A	N/A	75.00	90.00	15.00	15.00	18.00	2.52	37.80	OPEN	8.00	50.27	88.07	88.07
W15-85	1	VAD.	8-in	CS	N/A	104.98	N/A	N/A	N/A	N/A	N/A	N/A	83.00	98.00	15.00	15.00	24.00	3.36	50.40	OPEN	8.00	50.27	100.67	100.67
W15-86	1	VAD.	4-in	CS	N/A	136.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	0.00	0.00
W15-95	1	VAD.	8-in	CS	N/A	101.91	N/A	N/A	N/A	N/A	N/A	N/A	83.00	98.00	15.00	15.00	24.00	3.36	50.40	OPEN	8.00	50.27	100.67	100.67
W15-216	1	VAD.	4-in	SS	N/A	184.80	69.72	79.80	10.07	10.07	3.67	36.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	36.96	74.90
	2	VAD.	4-in	SS	N/A	184.80	174.51	184.80	10.34	10.34	3.67	37.95	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	37.95	N/A
W15-217	1	VAD.	4-in	SS	N/A	121.00	106.00	121.00	13.20	13.20	3.67	48.44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	48.44	48.44
W15-218	1	VAD.	4-in	SS	N/A	195.30	98.50	113.50	25.20	25.20	3.67	92.48	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	92.48	147.17
	2	VAD.	4-in	SS	N/A	195.30	180.40	195.30	14.90	14.90	3.67	54.68	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	54.68	N/A
W15-219	1	VAD.	4-in	SS	N/A	212.00	87.20	102.20	15.00	15.00	3.67	55.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	55.05	110.10
	2	VAD.	4-in	SS	N/A	212.00	167.20	182.20	15.00	15.00	3.67	55.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	55.05	N/A
W15-220	1	VAD.	4-in	SS	N/A	201.00	80.00	95.10	15.10	15.10	3.67	55.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	55.42	110.47
	2	VAD.	4-in	SS	N/A	201.00	155.00	170.00	15.00	15.00	3.67	55.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	55.05	N/A
W15-223	1	VAD.	3.5-in	SS	N/A	118.90	102.80	117.20	20.30	20.30	35.00	710.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	710.50	710.50
W18-1	1	WATER	6-in	CS	209.00	427.00	N/A	N/A	N/A	N/A	N/A	N/A	195.00	236.00	41.00	14.00	6.00	0.84	11.76	SUB.	8.00	0.00	11.76	11.76
	2	WATER	6-in	CS	209.00	427.00	N/A	N/A	N/A	N/A	N/A	N/A	238.00	240.00	2.00	0.00	BROKE	0.00	0.00	N/A	N/A	0.00	0.00	N/A
	3	WATER	6-in	CS	209.00	427.00	N/A	N/A	N/A	N/A	N/A	N/A	240.00	425.00	185.00	0.00	6.00	0.84	0.00	N/A	N/A	0.00	0.00	N/A
W18-2	1	WATER	8-in	CS	210.00	254.00	205.00	254.50	49.50	0.00	52.00	0.00	200.00	278.00	78.00	54.50	6.00	0.84	45.78	CLOSED	N/A	0.00	45.78	45.78
W18-6	1	WATER	6-in	CS	DRY	203.68	N/A	N/A	N/A	N/A	N/A	N/A	190.00	249.00	59.00	13.68	6.00	0.84	11.49	FILLED IN	8.00	50.27	61.76	61.76
	2	WATER	6-in	CS	DRY	203.68	N/A	N/A	N/A	N/A	N/A	N/A	250.00	298.00	48.00	0.00	4.00	0.56	0.00	N/A	N/A	0.00	0.00	N/A
W18-7	1	WATER	6-in	CS	DRY	203.30	196.00	216.00	20.00	0.00	46.00	0.00	190.00	250.00	60.00	13.30	6.00	0.84	11.17	FILLED IN	N/A	21.99	33.16	33.16
	2	WATER	6-in	CS	DRY	203.30	N/A	N/A	N/A	N/A	N/A	N/A	270.00	298.00	28.00	0.00	6.00	0.84	0.00	N/A	N/A	0.00	0.00	N/A

*TYPE: CS = Car. Steel, SS = Stainless Steel
*COR. FT = Corrected length is the length of open area above water and soil fill

WELL No.	INT. No.	WELL TYPE	CASE SIZE	CASE TYPE*	DEPTH TO WATER	DEPTH TO BOT.	SCREEN OPEN AREA (OA) INFORMATION: FEET BELOW TOP OF CASING TOP	FEET BELOW TOP OF CASING BOT.	TOTAL LENGTH (FT.)	*COR. LENGTH (FT.)	Sq.in/ft OPEN AREA	TOTAL SCREEN OA	PERFORATION OPEN AREA (OA) INFORMATION: FEET BELOW TOP OF CASING TOP	FEET BELOW TOP OF CASING BOT.	TOTAL LENGTH (FT.)	*COR. LENGTH (FT.)	PERF. PER FOOT	Sq.in/ft OPEN AREA	TOTAL PERF. OA	BOTTOM INFORMATION: STATUS	CASE I.D.	TOTAL BOT. OA	TOTALS: INT. OA (sq.in.)	WELL OA (sq.in.)
W18-9	1	WATER	6-in	CS	208.00	217.00	182.00	212.00	30.00	0.00	26.00	0.00	180.00	189.00	9.00	9.00	4.00	0.56	5.04	CLOSED	N/A	0.00	5.04	12.88
	2	WATER	6-in	CS	208.00	217.00	N/A	N/A	N/A	N/A	N/A	N/A	190.00	200.00	10.00	10.00	4.00	0.56	5.60	N/A	N/A	0.00	5.60	N/A
	3	WATER	6-in	CS	208.00	217.00	N/A	N/A	N/A	N/A	N/A	N/A	200.00	218.00	18.00	8.00	2.00	0.28	2.24	N/A	N/A	0.00	2.24	N/A
W18-10	1	WATER	6-in	CS	DRY	214.30	N/A	N/A	N/A	N/A	N/A	N/A	100.00	130.00	30.00	30.00	30.00	4.20	126.00	CLOSED	N/A	0.00	126.00	1614.10
	2	WATER	6-in	CS	DRY	214.30	N/A	N/A	N/A	N/A	N/A	N/A	150.00	180.00	30.00	30.00	30.00	4.20	126.00	CLOSED	N/A	0.00	126.00	N/A
	3	WATER	6-in	CS	DRY	214.30	188.00	220.00	32.00	25.70	53.00	1362.10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	1362.10	N/A
W18-11	1	WATER	6-in	CS	DRY	188.60	190.00	220.00	30.00	0.00	35.00	0.00	180.00	200.00	20.00	0.00	4.00	0.56	0.00	FILLED IN	4.00	12.57	12.57	12.57
	2	WATER	6-in	CS	DRY	188.60	N/A	N/A	N/A	N/A	N/A	N/A	200.00	218.00	18.00	0.00	2.00	0.28	0.00	N/A	N/A	0.00	0.00	N/A
W18-12	1	WATER	6-in	CS	DRY	212.60	194.00	214.00	20.00	0.00	30.00	0.00	190.00	218.00	28.00	22.60	4.00	0.56	12.66	FILLED IN	N/A	15.71	28.37	28.37
W18-17	1	WATER	8-in	CS	205.00	218.20	189.40	219.40	20.00	0.00	29.00	0.00	200.00	220.00	20.00	5.00	4.00	0.56	2.80	CLOSED	N/A	0.00	2.80	2.80
	2	WATER	8-in	CS	205.00	218.20	N/A	N/A	N/A	N/A	N/A	N/A	220.00	250.00	30.00	0.00	2.00	0.28	0.00	N/A	N/A	0.00	0.00	N/A
W18-18	1	WATER	8-in	CS	188.00	201.64	183.00	204.00	21.00	0.00	29.00	0.00	185.00	210.00	25.00	3.00	4.00	0.56	1.68	CLOSED	N/A	0.00	1.68	1.68
	2	WATER	8-in	CS	188.00	201.64	N/A	N/A	N/A	N/A	N/A	N/A	215.00	225.00	10.00	0.00	2.00	0.28	0.00	N/A	N/A	0.00	0.00	N/A
W18-19	1	WATER	6-in	CS	DRY	201.72	175.00	205.00	30.00	0.00	30.00	N/A	185.00	195.00	10.00	10.00	8.00	1.12	11.20	FILLED IN	N/A	0.00	11.20	11.20
	2	WATER	6-in	CS	DRY	201.72	N/A	N/A	N/A	N/A	N/A	N/A	220.00	250.00	30.00	0.00	4.00	0.56	0.00	N/A	N/A	0.00	0.00	N/A
W18-24	1	WATER	4-in	SS	220.15	240.00	205.50	235.50	30.00	14.65	45.00	659.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	659.25	659.25
	2	WATER	4-in	SS	220.15	240.00	230.00	240.00	10.00	0.00	82.00	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	N/A
W18-29	1	WATER	4-in	SS	121.90	135.00	119.00	135.00	N/A	2.90	13.00	37.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	37.70	37.70
W18-82	1	VAD.	6-in	CS	N/A	146.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-85	1	VAD.	6-in	CS	N/A	148.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-86	1	VAD.	6-in	CS	N/A	147.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-87	1	VAD.	6-in	CS	N/A	148.00	N/A	N/A	N/A	N/A	N/A	N/A	32.50	38.10	5.60	5.60	12.00	1.68	9.41	CLOSED	N/A	0.00	9.41	23.02
	2	VAD.	6-in	CS	N/A	148.00	N/A	N/A	N/A	N/A	N/A	N/A	64.70	67.90	3.20	3.20	12.00	1.68	5.38	N/A	N/A	0.00	5.38	N/A
	3	VAD.	6-in	CS	N/A	148.00	N/A	N/A	N/A	N/A	N/A	N/A	124.40	129.30	4.90	4.90	12.00	1.68	8.23	N/A	N/A	0.00	8.23	N/A
W18-88	1	VAD.	6-in	CS	N/A	150.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-89	1	VAD.	6-in	CS	N/A	150.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-93	1	VAD.	6-in	CS	N/A	138.00	N/A	N/A	N/A	N/A	N/A	N/A	63.00	77.00	14.00	14.00	24.00	3.36	47.04	CLOSED	N/A	0.00	47.04	47.04
W18-94	1	VAD.	6-in	CS	N/A	83.00	N/A	N/A	N/A	N/A	N/A	N/A	68.00	78.00	10.00	10.00	24.00	3.36	33.60	CLOSED	6.00	0.00	33.60	28.27
W18-95	1	VAD.	6-in	CS	N/A	77.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	6.00	28.27	28.27	28.27
W18-96	1	VAD.	2-in	SS	N/A	79.55	122.29	131.88	9.59	9.59	1.84	17.60	71.00	79.00	8.00	8.00	24.00	3.36	26.88	CLOSED	N/A	0.00	26.88	26.88
W18-97	1	VAD.	6-in	CS	N/A	86.23	N/A	N/A	N/A	N/A	N/A	N/A	63.00	75.00	12.00	12.00	24.00	3.36	40.32	CLOSED	N/A	0.00	40.32	40.32
W18-98	1	VAD.	6-in	CS	N/A	75.30	N/A	N/A	N/A	N/A	N/A	N/A	66.00	77.00	11.00	11.00	24.00	3.36	36.96	CLOSED	N/A	0.00	36.96	36.96
W18-99	1	VAD.	6-in	CS	N/A	132.00	N/A	N/A	N/A	N/A	N/A	N/A	93.00	103.00	10.00	10.00	24.00	3.36	33.60	CLOSED	N/A	0.00	33.60	33.60
W18-152	1	VAD.	8-in	CS	N/A	118.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	8.00	50.27	50.27	50.27
W18-153	1	VAD.	8-in	CS	N/A	110.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	8.00	50.27	50.27	50.27
W18-155	1	VAD.	10-in	CS	N/A	17.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	10.00	78.54	78.54	78.54
W18-157	1	VAD.	8-in	CS	N/A	110.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN	8.00	50.27	50.27	50.27
W18-171	1	VAD.	8-in	CS	N/A	131.00	N/A	N/A	N/A	N/A	N/A	N/A	19.80	24.50	4.70	4.70	12.00	1.68	7.90	CLOSED	N/A	0.00	7.90	112.90
	2	VAD.	8-in	CS	N/A	131.00	N/A	N/A	N/A	N/A	N/A	N/A	56.00	76.00	20.00	20.00	24.00	3.36	67.20	N/A	N/A	0.00	67.20	N/A
	3	VAD.	8-in	CS	N/A	131.00	N/A	N/A	N/A	N/A	N/A	N/A	114.50	129.50	15.00	15.00	18.00	2.52	37.80	N/A	N/A	0.00	37.80	N/A
W18-246	1	VAD.	4-in	SS	N/A	174.90	120.10	130.00	10.00	10.00	3.67	36.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	36.70	73.40
	2	VAD.	4-in	SS	N/A	174.90	164.90	175.00	10.00	10.00	3.67	36.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	36.70	N/A
W18-247	1	VAD.	4-in	SS	N/A	172.00	119.00	129.00	10.00	10.00	3.67	36.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	36.70	73.40
	2	VAD.	4-in	SS	N/A	172.00	162.00	172.00	10.00	10.00	3.67	36.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	36.70	N/A
W18-248	1	VAD.	4-in	SS	N/A	138.55	123.00	138.00	15.37	15.37	3.67	56.41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	56.41	56.41
W18-249	1	VAD.	4-in	SS	N/A	136.68	121.00	136.00	14.98	14.98	3.67	54.98	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	54.98	54.98
W18-252	1	VAD.	4-in	SS	N/A	228.50	113.20	133.20	20.00	20.00	3.67	73.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CLOSED	N/A	0.00	73.40	146.80
	2	VAD.	4-in	SS	N/A	228.50	165.10	185.10	20.00	20.00	3.67	73.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	73.40	N/A

*TYPE: CS = Car. Steel, SS = Stainless Steel
*COR. FT = Corrected length is the length of open area above water and soil fill

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WELL No.	FACILITY INFORMATION NAME	TYPE	DISTANCE TO FACILIT (FT)	COMMENTS
W10-9	241-T	Tank Farm		Only well with an open bottom screen BUT bottom is below wat
W10-15	241-T	Tank Farm		Pipe size, continuous wrap screen.
W10-16	241-T	Tank Farm		Pipe size, continuous wrap screen.
W10-17	241-TY	Tank Farm		Pipe size, continuous wrap screen.
W10-18	241-TY	Tank Farm		Pipe size, continuous wrap screen.
W11-1	216-T6	Crib		Two sets of perforations.
	216-T6	Crib		Open bottom casing
W11-27	241-T	Tank Farm		Pipe size, continuous wrap screen.
W11-28	241-T	Tank Farm		Pipe size, continuous wrap screen.
W14-12	241-TX	Tank Farm		Pipe size, continuous wrap screen.
W14-51		Crib		6" Well, Plugged at 75', No other records available.
W15-4		Crib		Assume 2 cuts/rd/ft. Actual value unknown.
W15-5	Z-9	Trench	240	Two sets of perforations.
	Z-9	Trench	240	Gravel pack covers lower set and part of upper.
W15-6	Z-9	Trench	110	Assume 2 cuts/rd/ft. Actual value unknown.
	Z-9	Trench	110	
W15-8	Z-9	Trench	50	Casing capped at bottom, no perfs./screen documented.
W15-9	Z-9	Trench	5	4" case set in an open, perforated 6" case.
W15-12	241-TY	Tank Farm		Casing capped at bottom, perfs. only.
W15-13	241-TY	Tank Farm		Casing capped at bottom.
	241-TY	Tank Farm		Two sets of perforations.
W15-22	241-TX	Tank Farm		Telescoping screen, assume continuous wire wrap.
W15-64		Crib		Grout plug. Perf'd with Mills Knife, assume .14 sq in. hole.
W15-66		Crib		Grout plug with no perfs or screen indicated.
W15-76		Crib		Assumed open bottom, no records to indicate plug.
W15-82	Z-9	Trench	50	Assumed open bottom, no records to indicate plug.
W15-84	Z-9	Trench	40	Assumed open bottom, no records to indicate plug.
W15-85	Z-9	Trench	50	Assumed open bottom, no records to indicate plug.
W15-86	Z-9	Trench	1	Bottom plugged. No perfs or screen. 4" in 8" case.
W15-95	Z-9	Trench	5	Assumed open bottom, no records to indicate plug.
W15-216	Z-9	Trench	120	Louvered screen, bottom capped.
	Z-9	Trench	12099	Louvered screen, bottom capped.
W15-217	Z-9	Trench	40	Louvered screen, bottom capped.
W15-218	Z-9	Trench		Louvered screen, bottom capped.
	Z-9	Trench		Louvered screen, bottom capped.
W15-219	Z-9	Trench		Louvered screen, bottom capped.
	Z-9	Trench		Louvered screen, bottom capped.
W15-220	Z-9	Trench		Louvered screen, bottom capped.
	Z-9	Trench		Louvered screen, bottom capped.
W15-223	Z-9	Trench		Louvered screen, bottom capped.
W18-1	Z-12	Crib	130	6" case in a perforated, open bottom 8" case
	Z-12	Crib	130	8" case is parted for two feet thus two perf. intervals
	Z-12	Crib	130	and a 24" section open to soil.
W18-2	Z-12	Crib	2	Screen exists w/in the perf. interval, lower perfs. plugged.
W18-6	Z-1A	Tile Field	7	6" case in 8", filled in from 203.68' to 300'.
	Z-1A	Tile Field	7	
W18-7	Z-1A	Tile Field	8	6" telescope screen in a 8" case within perf. interval.
	Z-1A	Tile Field	8	AREA OF 8" CASE - 6" CASE=BOTTOM OPEN AREA

WELL No.	FACILITY INFORMATION NAME	TYPE	DISTANCE TO FACILIT (FT)	COMMENTS
W18-9	Z-18	Crib	0	6" telescope screen in a 6" case within perf. interval.
	Z-18	Crib	0	Plugged at 217'
	Z-18	Crib	0	CASING BOTTOM IS OPEN BELOW THE PLUG
W18-10	Z-18	Crib	2	Perforated in 1994, 2 sets
	Z-18	Crib	2	
	Z-18	Crib	2	Wire wrap screen at bottom
W18-11	Z-18	Crib	0	4" Screen set at top of perf. interval, filled in completely.
	Z-18	Crib	0	Vapor must pass through the perfs., screen and fill.
W18-12	Z-18	Crib	0	Telescoping screen in perf. interval, partially filled in.
W18-17	Z-20	Trench		Tel. screen in perf. interval, plug at screen bottom.
	Z-20	Trench		Filled in and plugged.
W18-18	Z-20	Trench		Assume 6" screen on packer, fill starts at bottom of screen.
	Z-20	Trench		Bottom of case is plugged.
W18-19	Z-20	Trench		Screen in upper perf. interval, lower interval filled in.
	Z-20	Trench		Case bottom is open but filled up to screen.
W18-24	Z-18	Crib	90	Two screens, one 4" and one 8".
	Z-18	Crib		Casing is 4" but the borehole is 8-16".
W18-29	Z-20	Trench		#5 slot equates to 13 sq.in., verified with Johnson Mfg.
W18-82	None	None	N/A	No perforations or screens. No record of any bottom plug
W18-85	Z-1A	Tile Field	30	No perforations or screens. No record of any bottom plug.
W18-86	Z-1A	Tile Field	40	No perforations or screens. No record of any bottom plug.
W18-87	Z-1A	Tile Field	40	Three perforated intervals. Cement plug at bottom.
	Z-1A	Tile Field	40	
	Z-1A	Tile Field	40	
W18-88	Z-1A	Tile Field	60	No perforations or screens. No record of any bottom plug.
W18-89	Z-1A	Tile Field	50	No perforations or screens. No record of any bottom plug.
W18-93	Z-18	Crib	0	No perforations or screens. No record of any bottom plug.
W18-94	Z-18	Crib	3	No perforations or screens. No record of any bottom plug.
W18-95	Z-18	Crib	3	No perforations or screens. No record of any bottom plug.
W18-96	Z-18	Crib	0	No perforations or screens. No record of any bottom plug.
W18-97	Z-18	Crib	2	No perforations or screens. No record of any bottom plug.
W18-98	Z-18	Crib	3	No perforations or screens. No record of any bottom plug.
W18-99	None	None	N/A	No perforations or screens. No record of any bottom plug.
W18-152	Z-12	Crib	1	No perforations or screens. No record of any bottom plug.
W18-153	Z-12	Crib	0	No perforations or screens. No record of any bottom plug.
W18-155	Z-12	Crib	20	No perforations or screens. No record of any bottom plug.
W18-157	Z-12	Crib	1	No perforations or screens. No record of any bottom plug.
W18-171	Z-1A	Tile Field	15	Three perforated intervals. Cement plug at bottom.
	Z-1A	Tile Field		
	Z-1A	Tile Field		
W18-246	Z-1A	Tile Field	70	Louvered screen.
	Z-1A	Tile Field	70	Louvered screen.
W18-247	Z-18	Crib	70	Louvered screen.
	Z-18	Crib	70	Louvered screen.
W18-248	Z-1A	Tile Field	20	Louvered screen.
W18-249	Z-18	Crib	10	Louvered screen.
W18-252	None	None	N/A	Louvered screen.
	None	None	N/A	Louvered screen.

APPENDIX C
CALCULATIONS USED TO DERIVE VADOSE OPEN AREA

I. VADOSE ZONE OPEN AREA CALCULATION ASSUMPTIONS:

A. TOTAL SCREEN OPEN AREA = CORRECTED LENGTH (FT)* x Sq.in. OF OPEN AREA PER LINEAR FOOT.
B. TOTAL PERF. OPEN AREA = CORRECTED LENGTH (FT)* x # OF PERFS PER FOOT X Sq.in. OF OPEN AREA PER P
C. TOTAL BOTTOM OPEN AREA = AREA OF APPLICABLE CIRCLE.
D. INTERVAL TOTAL OPEN AREA (sq.in.) = THE SUM OF ALL THREE OPEN AREA TYPES IN THE APPLICABLE INTER
E. BOREHOLE TOTAL OPEN AREA (sq.in.) = THE SUM OF ALL OPEN AREA INTERVALS IN THE APPLICABLE BOREH

*Corrected length accounts for water and sand fill levels in each borehole.

II. SCREEN SPECIFICATIONS:

A. TYPE: CONTINUOUS WIRE WRAP, FROM JOHNSON WELL SCREENS.

Stainless Steel Vee-Wire TELESCOPE SIZE Screens.(1)

OPEN AREA (SQ.IN.) PER LINEAR FOOT.			
PIPE	SLOT SIZE		
SIZE	0.005	0.010	0.020
4"	20.00	35.00	13.00
6"	30.00	53.00	N/A
8"	29.00	52.00	N/A

Stainless Steel Vee-Wire PIPE SIZE Screens.(1)

OPEN AREA (SQ.IN.) PER LINEAR FOOT.			
PIPE	SLOT SIZE		
SIZE	0.005	0.010	0.020
3"	N/A	20.00	35.00
4"	13.00	26.00	45.00
5"	N/A	30.00	53.00
8"	N/A	33.00	60.00

B. TYPE: LOUVERED, FROM ROSCOE MOSS WELL SCREENS.(2)

4" DIA., .020 SLOT SIZE = 3.67 sq.in. PER LINEAR FOOT

III. PERFORATION SPECIFICATIONS:

A. TYPE: PERFHAWK, FROM HAWK INDUSTRIES, INC.(3)

WIDTH OF CUT: .28125"
LENGTH OF CUT: x.5"
0.140 ASSUMED OPEN AREA PER CUT (sq.in.).

B. TYPE: MILLS KNIFE, HOLE SIZE IS APPROX. THE SAME AS THE PERFHAWK.
W15-64 IS THE ONLY DOCUMENTED WELL WITH THIS TYPE OF PERFORATION.

IV. BOTTOM OF CASING AREAS (SQ.IN.).

DIA.	AREA
3"	7.07
4"	12.57
6"	28.27
8"	50.27
10"	78.54

1. Johnson Filtration Systems Inc., St. Paul, MN, Product Literature, 1991.
2. Roscoe Moss Co., Los Angeles, CA, per telephone communication, 1993.
3. Hawk Industries, Inc., Long Beach, CA, Product Literature, 1989.

APPENDIX D
NONROUTINE FARFIELD MONITORING DATA

WELL NUMBER	DATE	OVM ppmv
299-W6-1	5/19/93	0
299-W6-2	5/19/93	0
299-W6-3	5/19/93	0
299-W6-4	5/19/93	0
299-W6-9	5/19/93	0
299-W6-10	5/19/93	0
299-W7-1	5/19/93	0
299-W7-9	5/19/93	0
299-W7-10	5/19/93	0
299-W7-12	5/19/93	0
299-W8-1	5/19/93	0
299-W9-1	5/19/93	0
299-W10-1	5/19/93	0
299-W10-2	5/19/93	0
299-W10-4	5/19/93	0
299-W10-5	5/19/93	0
299-W10-8	5/19/93	0
299-W10-10	5/19/93	0
299-W10-11	5/19/93	0
299-W10-12	5/19/93	0
299-W10-13	5/19/93	0
299-W10-14	5/19/93	0
299-W10-69	5/19/93	0
299-W10-70	5/19/93	0
299-W10-72	5/19/93	0
299-W10-73	5/19/93	0
299-W10-76	5/19/93	0
299-W10-77	5/19/93	0
299-W10-78	5/19/93	0
299-W10-79	5/19/93	0
299-W10-169	5/19/93	0
299-W10-170	5/19/93	0
299-W11-7	5/19/93	0
299-W11-14	5/19/93	0
299-W11-15	5/19/93	0
299-W11-16	5/19/93	0
299-W11-17	5/19/93	0
299-W11-18	5/19/93	0
299-W11-19	5/19/93	0
299-W11-20	5/19/93	0
299-W11-21	5/19/93	0
299-W11-23	5/19/93	0
299-W11-24	5/19/93	0
299-W11-31	5/19/93	0
299-W11-54	5/19/93	0
299-W11-55	5/19/93	0
299-W11-56	5/19/93	0
299-W11-57	5/19/93	0
299-W11-58	5/19/93	0
299-W11-60	5/19/93	0
299-W11-61	5/19/93	0
299-W11-62	5/19/93	0
299-W11-63	5/19/93	0
299-W11-64	5/19/93	0
299-W11-65	5/19/93	0
299-W11-66	5/19/93	0

WELL NUMBER	DATE	OVM ppmv
299-W11-67	5/19/93	0
299-W11-68	5/19/93	0
299-W11-69	5/19/93	0
299-W11-79	5/19/93	0
299-W11-80	5/19/93	0
299-W11-81	5/19/93	0
299-W14-52	5/12/93	0
299-W15-1	5/12/93	11
299-W15-7	5/12/93	0
299-W15-10	5/12/93	0
299-W15-14	5/13/93	0
299-W15-15	5/13/93	0
299-W15-16	5/13/93	0
299-W15-17	5/12/93	0
299-W15-17	5/13/93	0
299-W15-18	5/12/93	0
299-W15-18	5/13/93	0
299-W15-20	5/12/93	0
299-W15-23	5/12/93	0
299-W15-24	5/13/93	0
299-W15-52	5/12/93	0
299-W15-53	5/12/93	0
299-W15-54	5/12/93	0
299-W15-55	5/12/93	0
299-W15-56	5/12/93	0
299-W15-57	5/12/93	0
299-W15-59	5/12/93	0
299-W15-62	5/12/93	0
299-W15-63	5/12/93	0
299-W15-65	5/12/93	0
299-W15-80	5/12/93	0
299-W15-81	5/12/93	0
299-W15-151	5/13/93	0
299-W15-154	5/13/93	0
299-W15-209	5/12/93	0
299-W15-210	5/12/93	0
299-W15-211	5/12/93	0
299-W15-212	5/12/93	0
299-W18-4	5/13/93	0
299-W18-5	5/13/93	0
299-W18-20	5/13/93	0
299-W18-21	5/13/93	0
299-W18-22	5/13/93	0
299-W18-23	5/13/93	0
299-W18-25	5/13/93	0
299-W18-26	5/13/93	0
299-W18-27	5/13/93	0
299-W18-28	5/13/93	0
299-W18-30	5/13/93	0
299-W18-31	5/13/93	0
299-W18-32	5/13/93	0
299-W19-27	6/28/93	17
299-W19-91	6/28/93	13
699-39-79	5/19/93	0
699-40-80	5/19/93	0

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Environmental Restoration Field Sampling	Date 6/21/94
Project Title/Work Order		EDT No. 600222
Carbon Tetrachloride ERA Soil-Gas Baseline Monitoring		ECN No. n/a

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J. D. Fancher (10)	N3-05	X			
W. S. Thompson	N3-05	X			
W.H. Price	N3-05	X			
V.J. Rohay	H6-06	X			
G.C. Henckel	H6-04	X			
T.W. Spicer	T1-95	X			
S.A. Driggers	H6-04	X			
J.N. Fisler	H6-04	X			
B.G. Tuttle	N3-06	X			
R.J. Schmitt	N3-05	X			
M.G. Gardner	N3-06	X			
S.H. Worley	N3-06	X			
J.M. Jimenez	N3-05	X			
M.S. Kowalski	N3-06	X			
S.E. Kos	H6-06	X			
K.J. Allwine	K6-11	X			
G.I. Goldberg	A5-19	X			
Central Files (2)	L8-04	X			
Information Release(2)	H4-17	X			
EPIC (2)	H6-08	X			

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